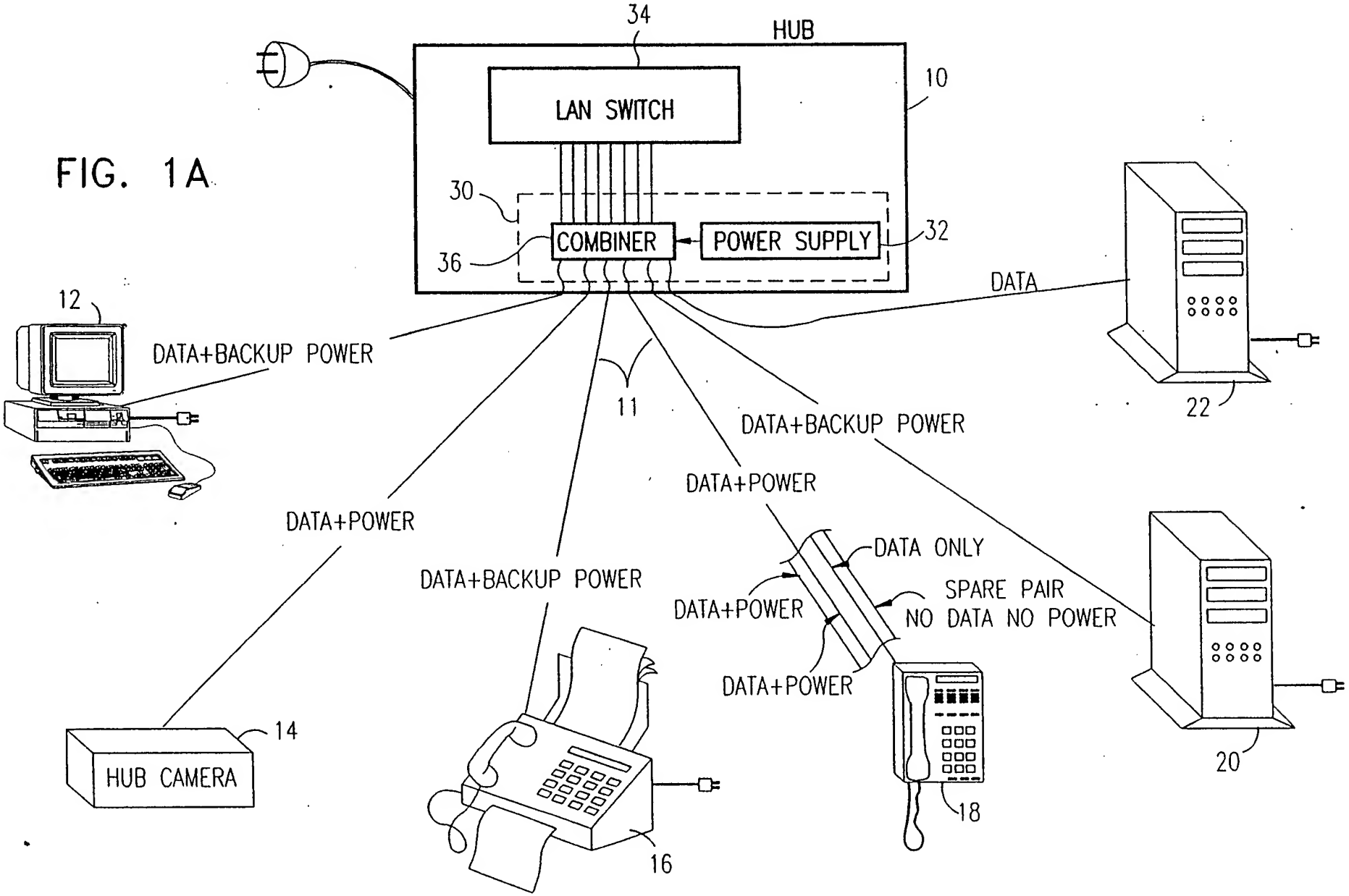
FIG. 1A


34
HUB
10
LAN SWITCH
30
COMBINER
POWER SUPPLY
32
36
DATA
12
DATA+BACKUP POWER
11
22
DATA+BACKUP POWER
DATA+POWER
DATA+POWER
DATA ONLY
SPARE PAIR
NO DATA NO POWER
DATA+BACKUP POWER
DATA+POWER
DATA+POWER
20
14
HUB CAMERA
16
18

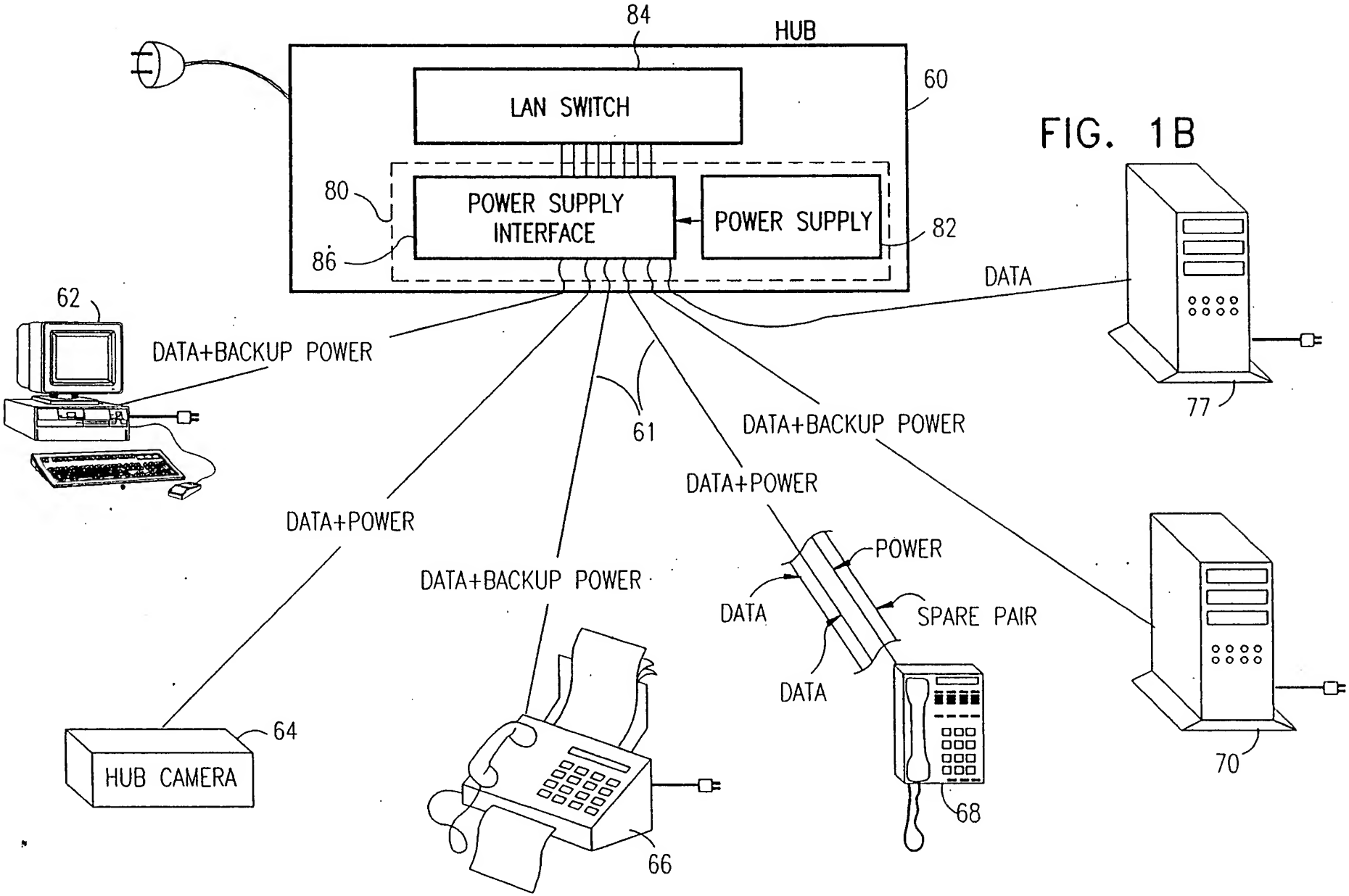

84
HUB
LAN SWITCH
60
80
POWER SUPPLY INTERFACE
POWER SUPPLY
82
86
62
DATA
DATA+BACKUP POWER
61
77
DATA+BACKUP POWER
DATA+POWER
DATA+POWER
POWER
DATA
SPARE PAIR
DATA
DATA+BACKUP POWER
64
HUB CAMERA
66
68
70

FIG. 1B

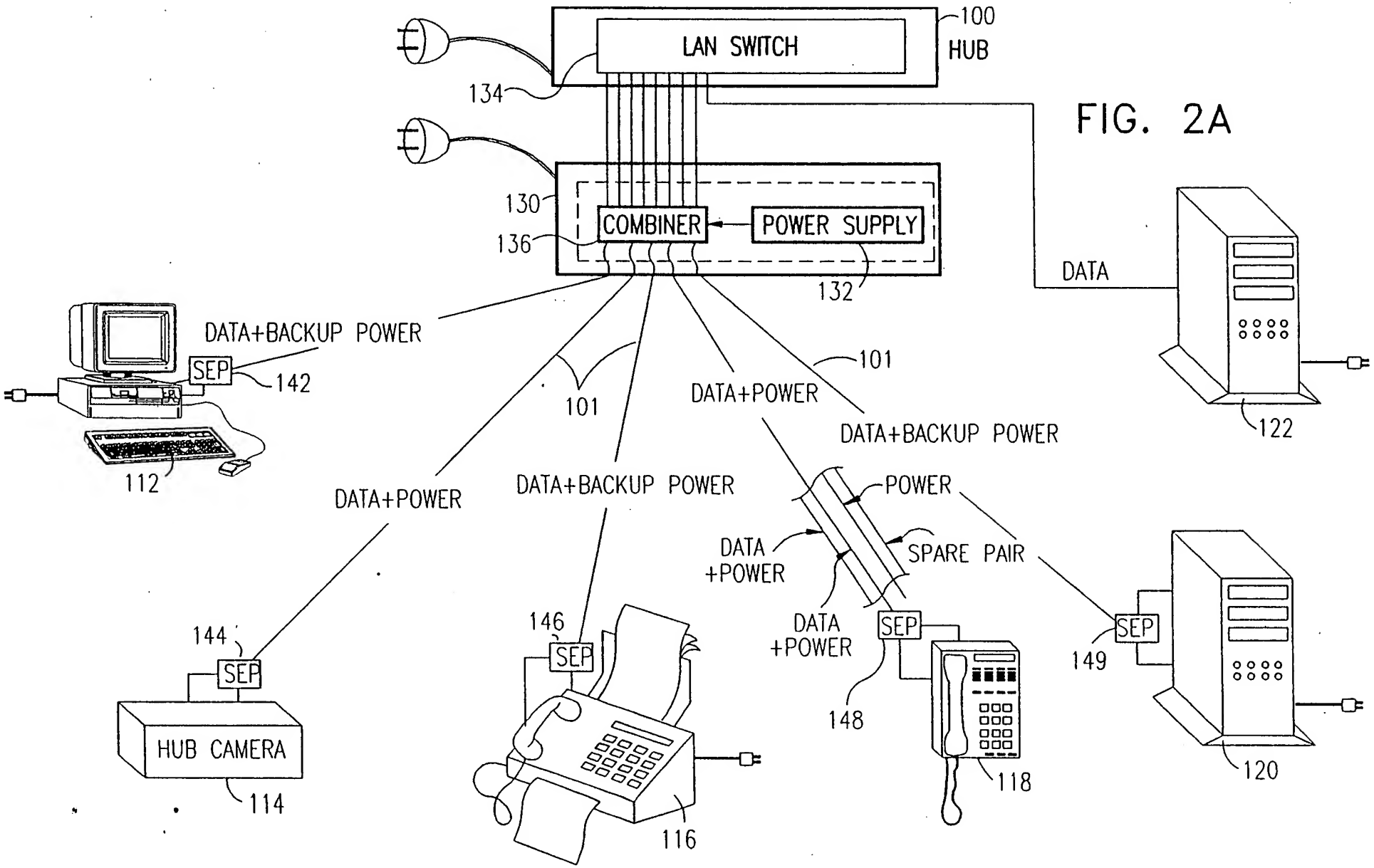

LAN SWITCH
100
HUB
134
130
COMBINER
POWER SUPPLY
136
132
DATA
122
DATA+BACKUP POWER
SEP
142
112
101
101
DATA+POWER
DATA+BACKUP POWER
DATA+POWER
DATA+BACKUP POWER
POWER
DATA
+POWER
SPARE PAIR
DATA
+POWER
SEP
148
118
SEP
149
120
144
SEP
HUB CAMERA
114
146
SEP
116

FIG. 2A

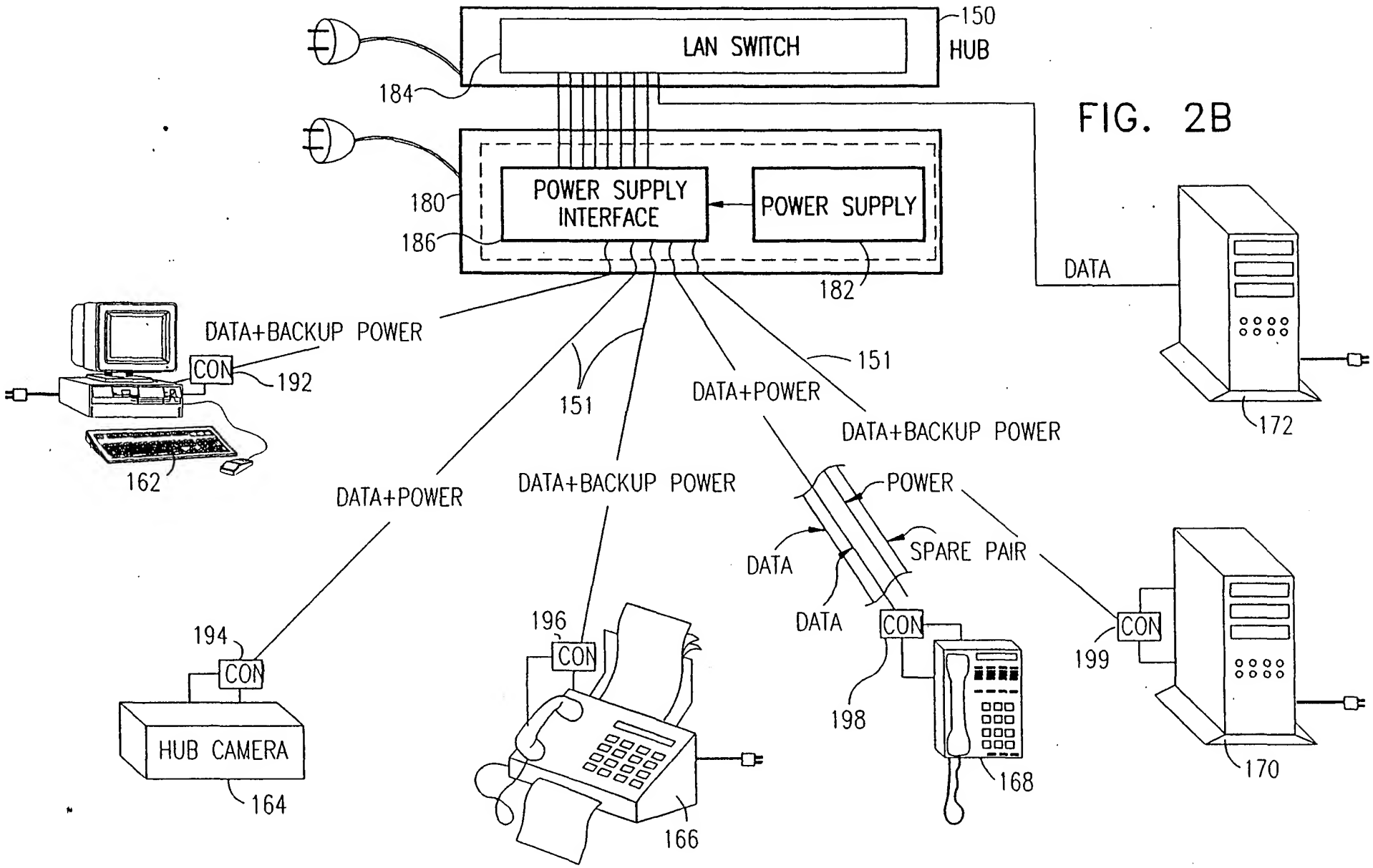

LAN SWITCH
150
HUB
184
180
POWER SUPPLY INTERFACE
POWER SUPPLY
186
182
DATA
172
DATA+BACKUP POWER
CON
192
162
151
151
DATA+POWER
DATA+BACKUP POWER
DATA+POWER
DATA+BACKUP POWER
POWER
SPARE PAIR
DATA
DATA
CON
198
168
199
CON
170
194
CON
HUB CAMERA
164
196
CON
166

FIG. 2B

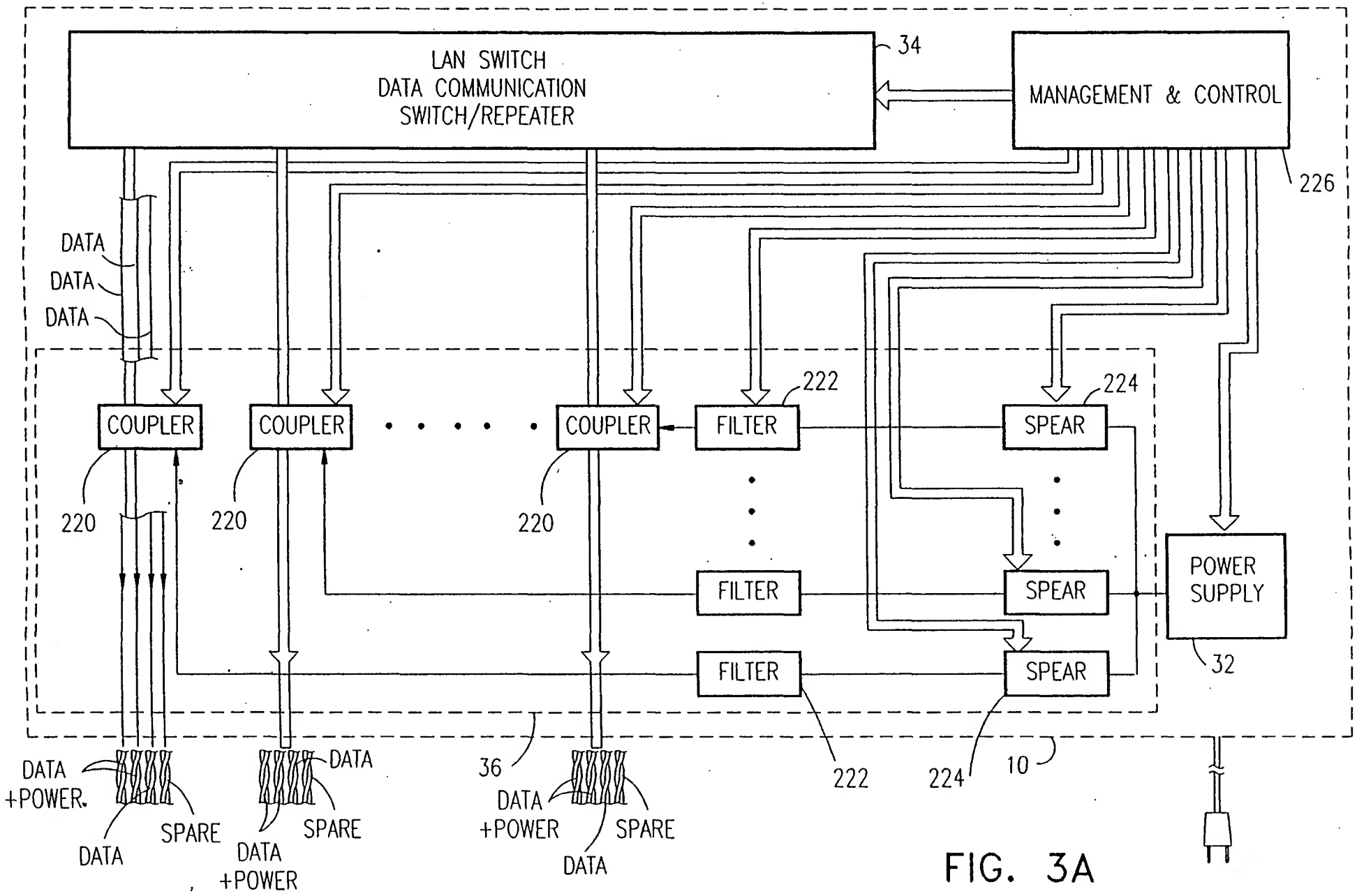

LAN SWITCH
DATA COMMUNICATION
SWITCH/REPEATER
34
MANAGEMENT & CONTROL
226
DATA
DATA
DATA
COUPLER
COUPLER
COUPLER
220
220
220
222
224
FILTER
FILTER
FILTER
SPEAR
SPEAR
SPEAR
POWER
SUPPLY
32
10
36
DATA
+POWER
SPARE
DATA
DATA
+POWER
SPARE
DATA
DATA
+POWER
SPARE
DATA
222
224

FIG. 3A

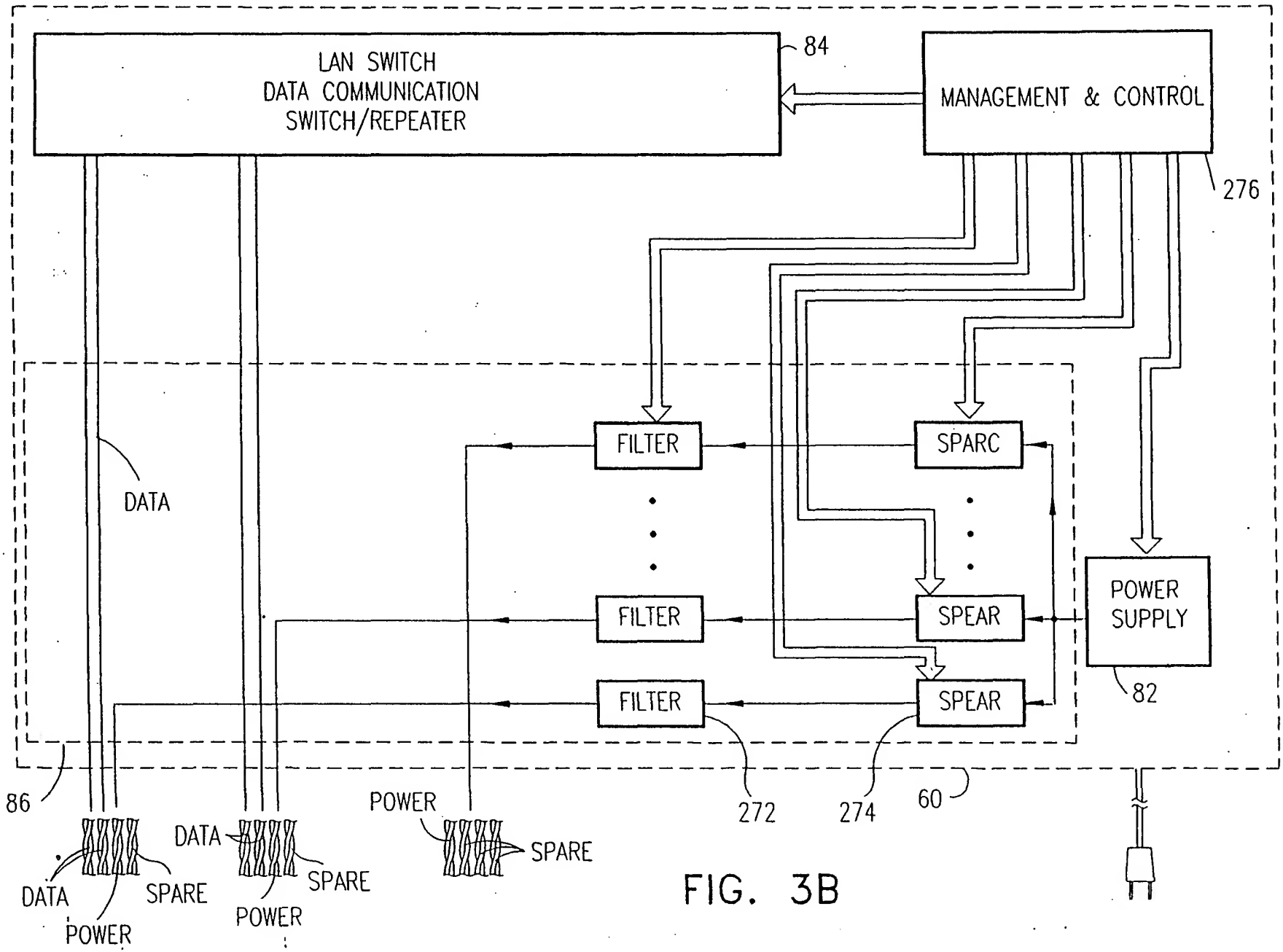

LAN SWITCH
DATA COMMUNICATION
SWITCH/REPEATER
84
MANAGEMENT & CONTROL
276
DATA
FILTER
SPARC
FILTER
SPEAR
FILTER
SPEAR
POWER
SUPPLY
82
86
272
274
60
POWER
SPARE
DATA
SPARE
DATA
SPARE
POWER
POWER

FIG. 3B

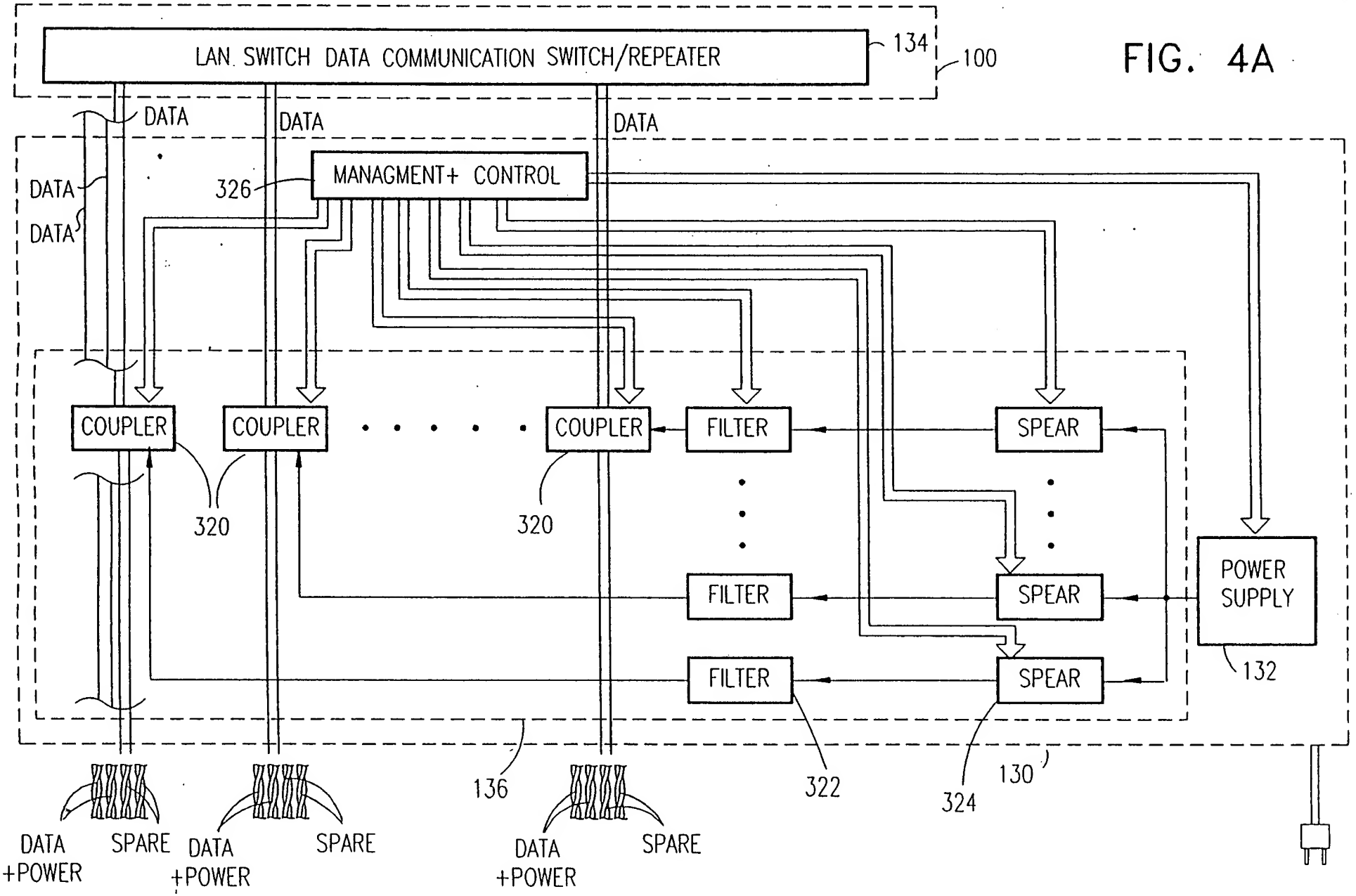

LAN SWITCH DATA COMMUNICATION SWITCH/REPEATER
134
100
DATA
DATA
DATA
DATA
DATA
MANAGMENT+ CONTROL
326
COUPLER
COUPLER
COUPLER
320
320
FILTER
FILTER
FILTER
SPEAR
SPEAR
SPEAR
POWER SUPPLY
132
136
322
324
130
DATA +POWER
SPARE
DATA +POWER
SPARE
DATA +POWER
SPARE

FIG. 4A

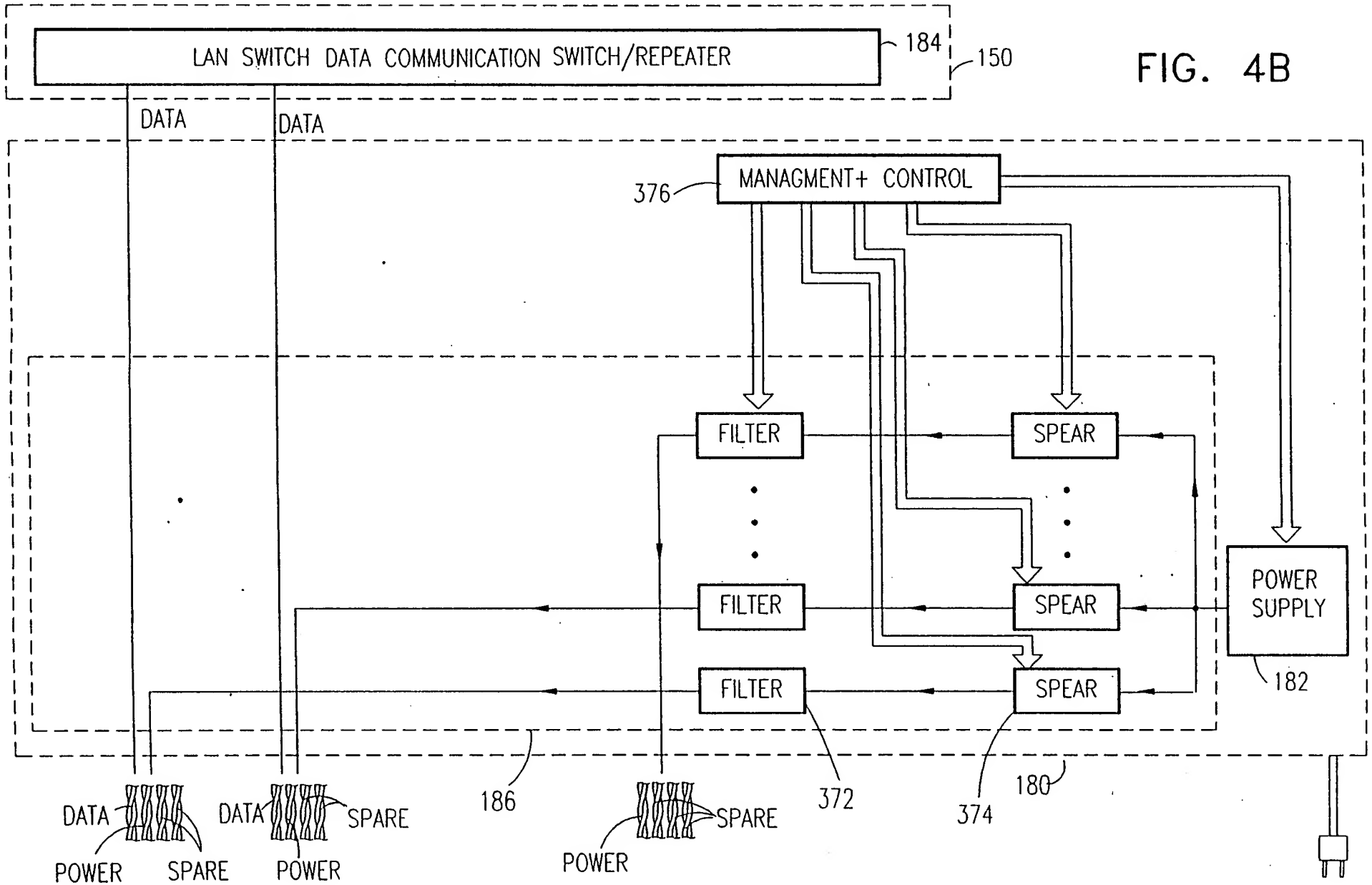

LAN SWITCH DATA COMMUNICATION SWITCH/REPEATER
184
150
DATA
DATA
376
MANAGMENT+ CONTROL
FILTER
SPEAR
FILTER
SPEAR
FILTER
SPEAR
POWER SUPPLY
182
DATA
POWER
SPARE
DATA
SPARE
POWER
186
SPARE
POWER
372
374
180

FIG. 4B

FIG. 5

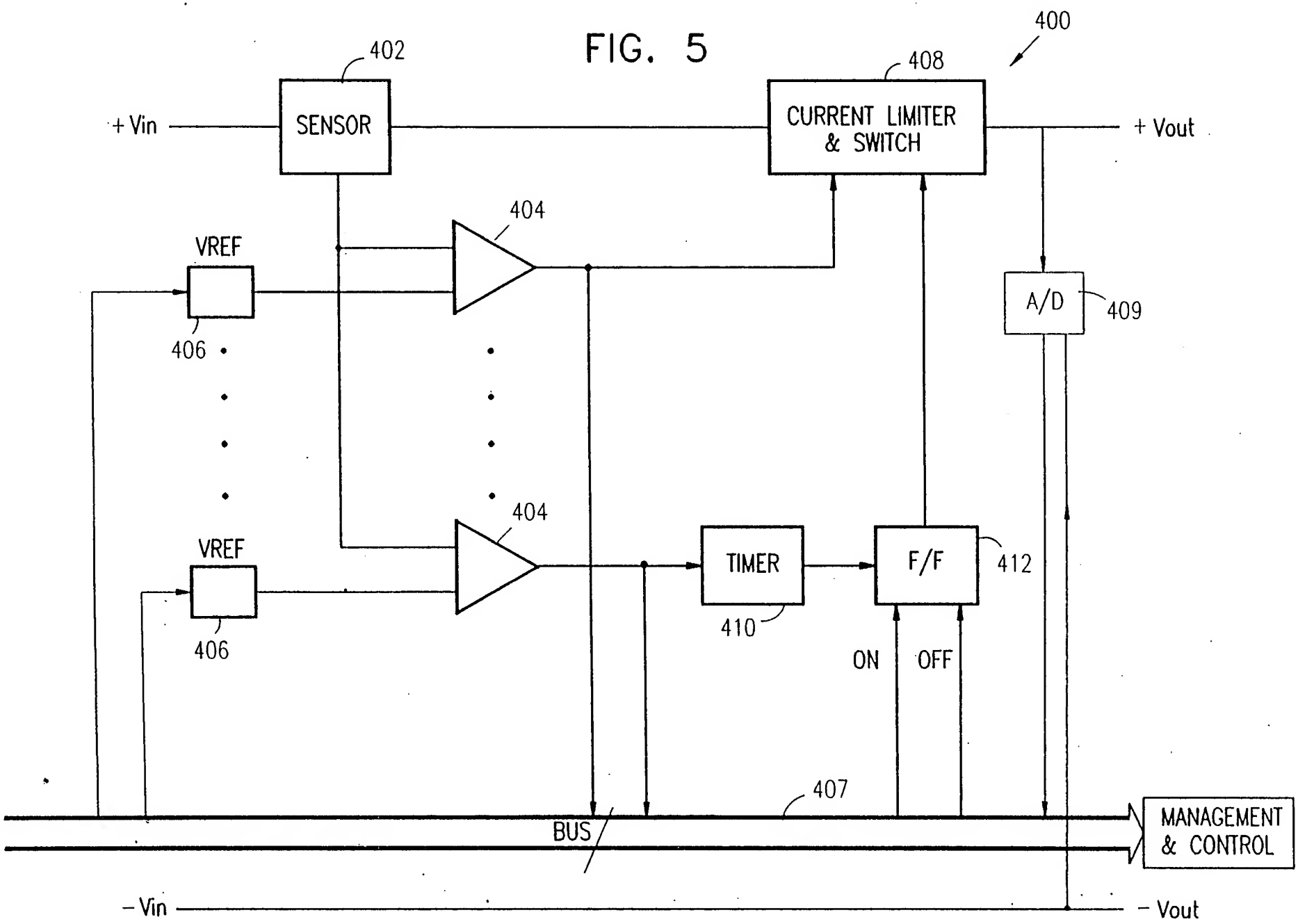

400
402
SENSOR
408
CURRENT LIMITER & SWITCH
+ Vin
+ Vout
404
VREF
406
A/D
409
404
VREF
406
TIMER
410
F/F
412
ON
OFF
407
BUS
MANAGEMENT & CONTROL
– Vin
– Vout

FIG. 6

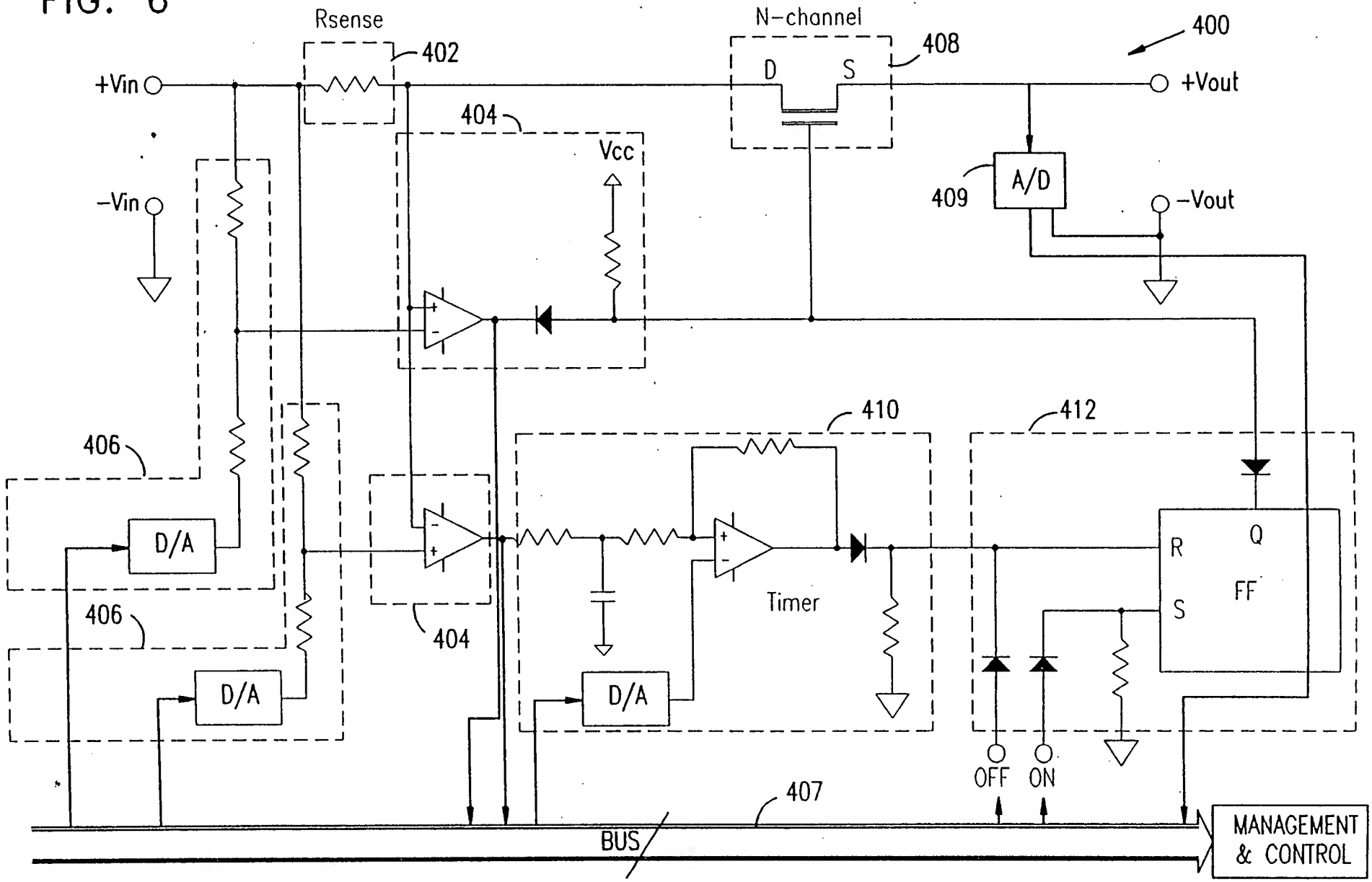

Rsense
402
N-channel
408
400
D
S
+Vin
+Vout
404
Vcc
-Vin
409
A/D
-Vout
406
D/A
406
D/A
404
410
412
Timer
D/A
R
Q
S
FF
OFF
ON
407
BUS
MANAGEMENT
& CONTROL

FIG. 7A

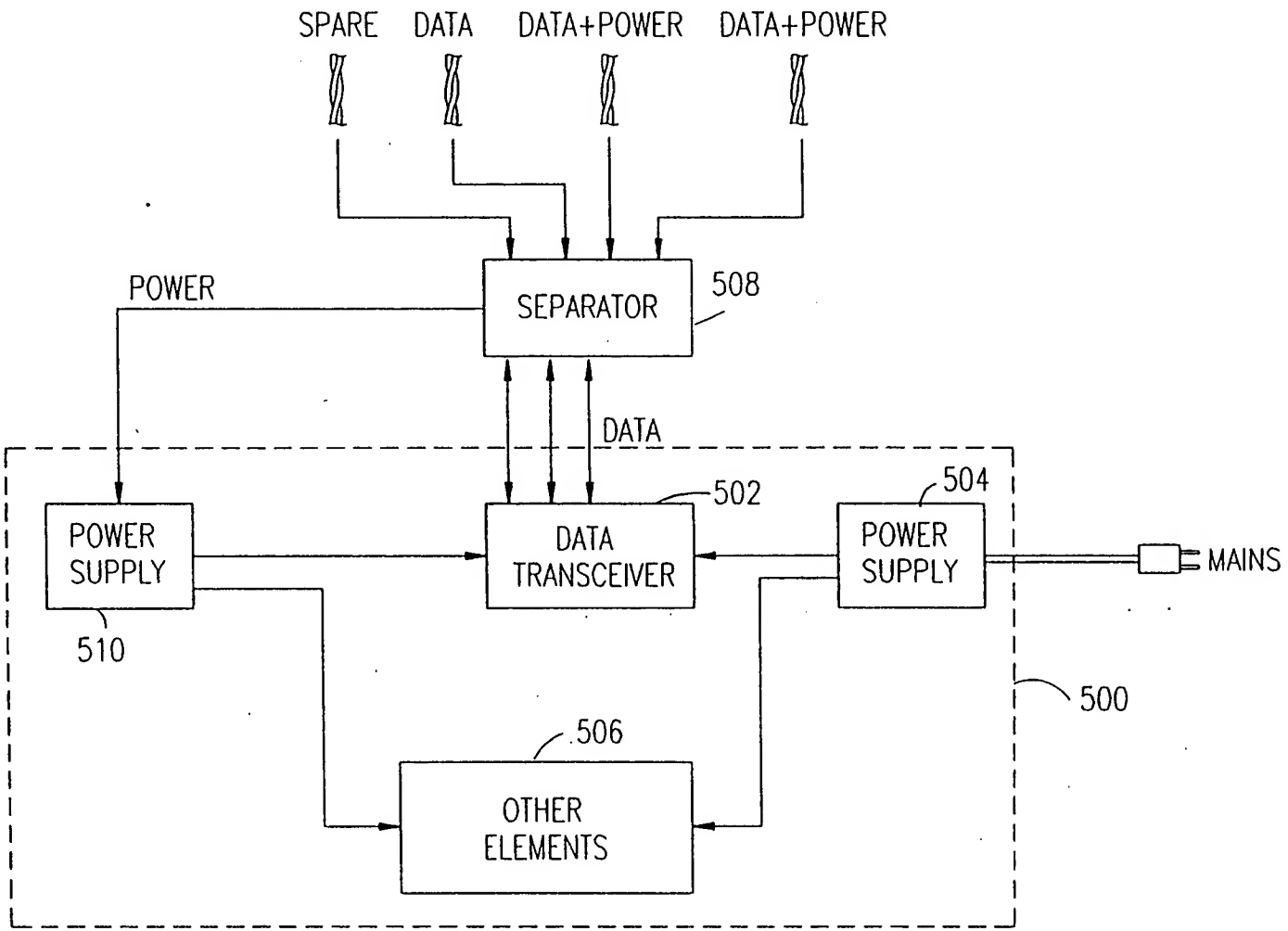
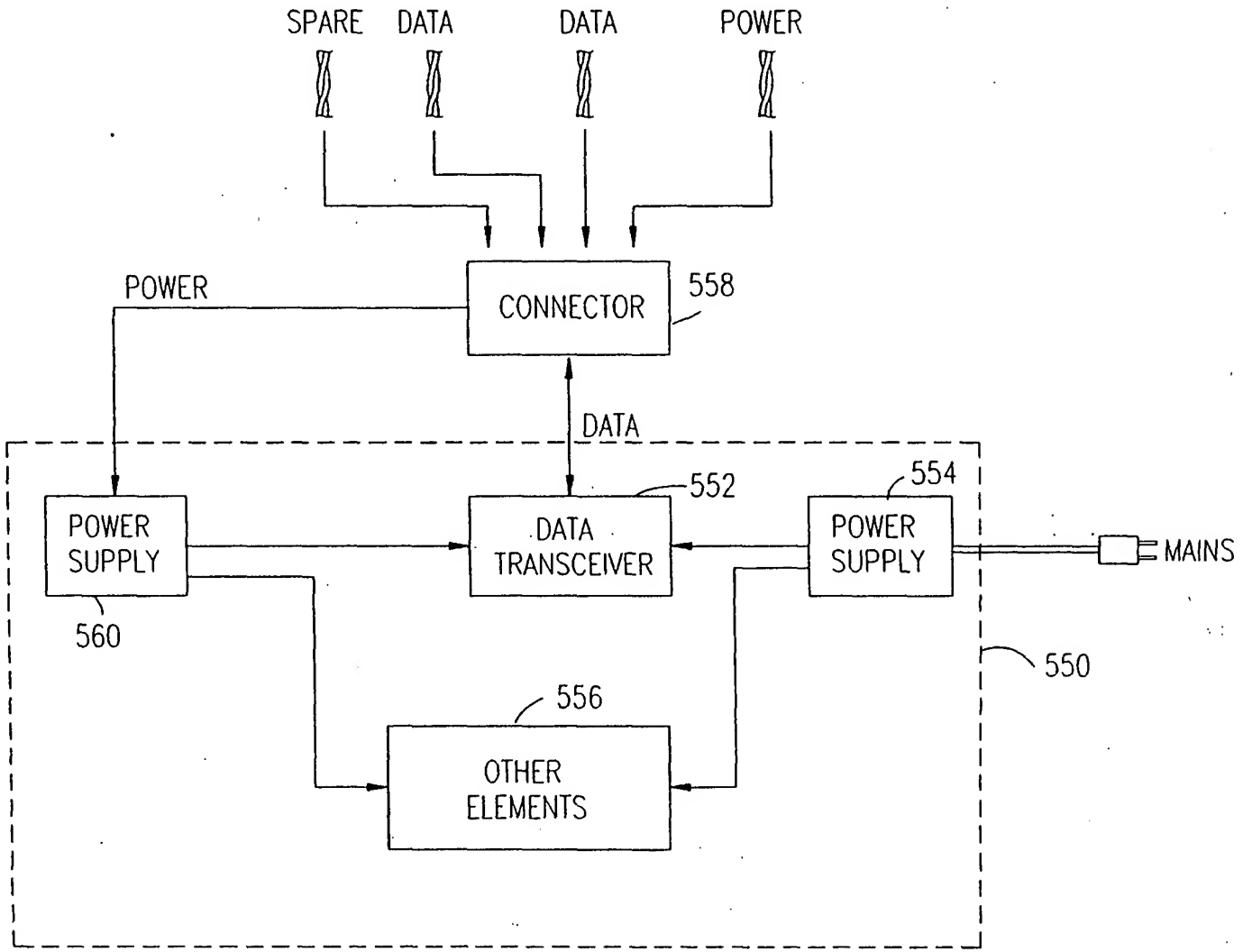

SPARE
DATA
DATA+POWER
DATA+POWER
POWER
SEPARATOR
508
DATA
502
504
POWER SUPPLY
DATA TRANSCEIVER
POWER SUPPLY
MAINS
510
500
506
OTHER ELEMENTS

FIG. .7B


SPARE
DATA
DATA
POWER
POWER
CONNECTOR
558
DATA
552
554
POWER SUPPLY
DATA TRANSCEIVER
POWER SUPPLY
MAINS
560
550
556
OTHER ELEMENTS

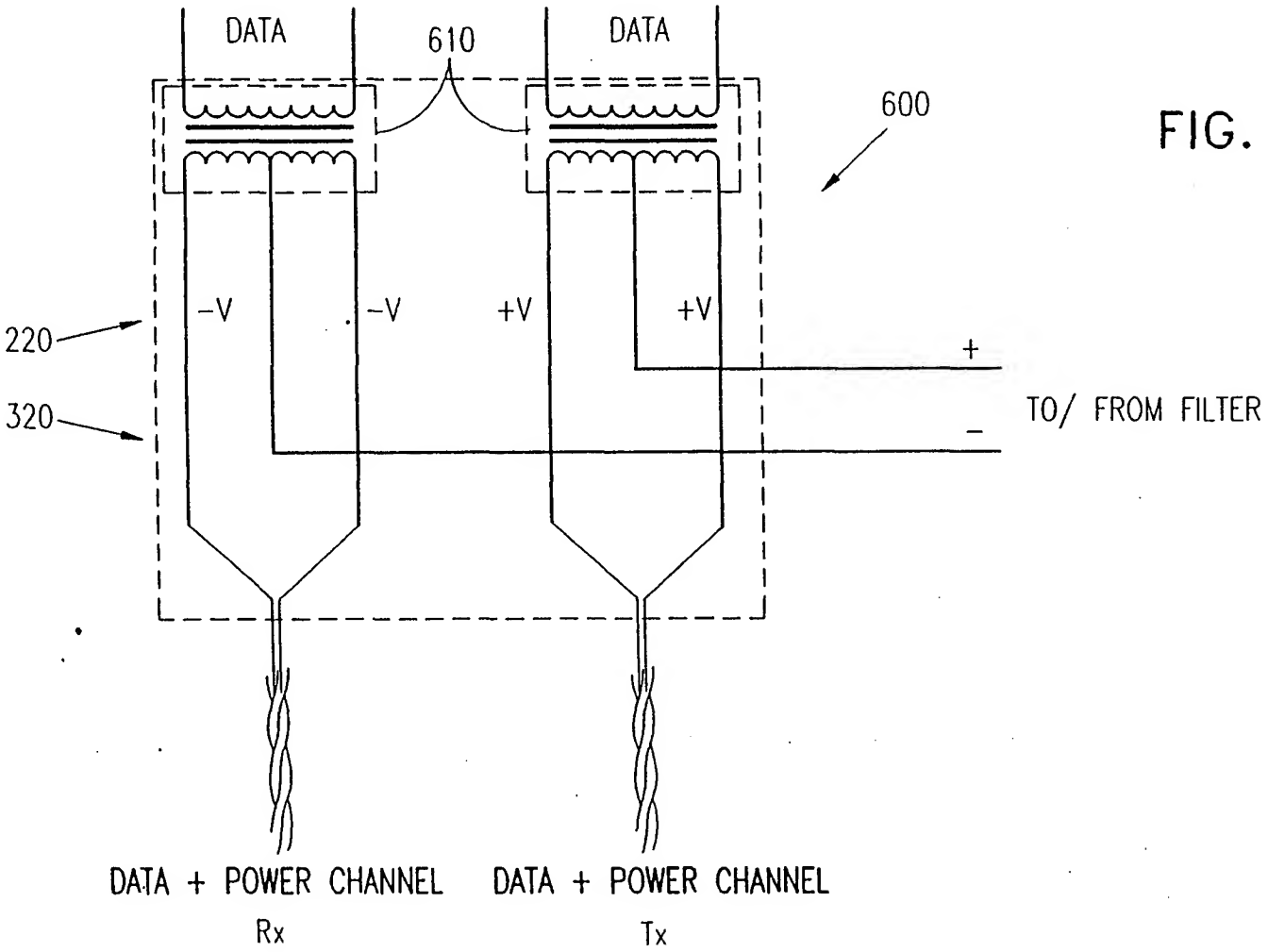
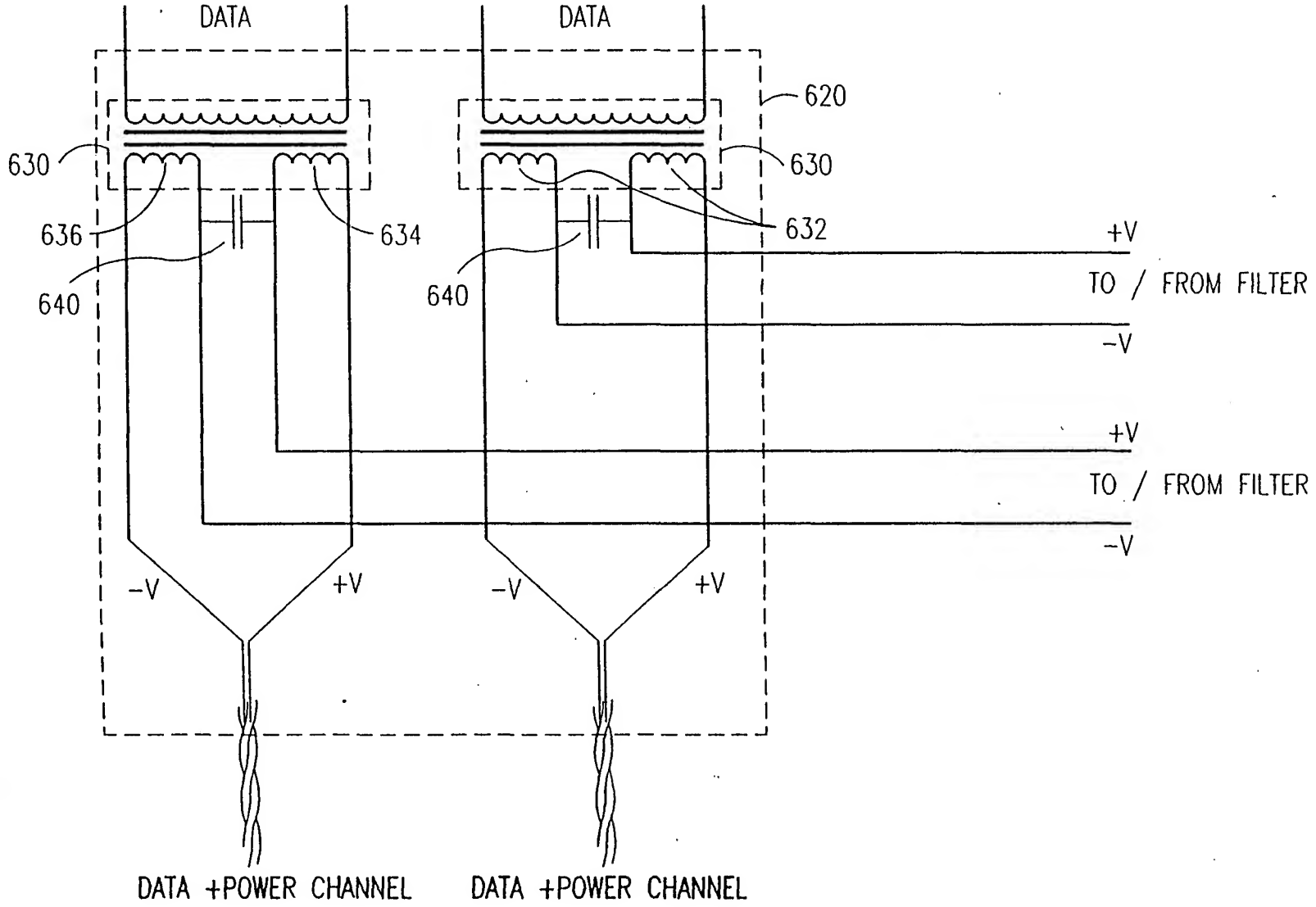

DATA
610
DATA
600
-V
-V
+V
+V
220
320
+
-
TO/ FROM FILTER
DATA + POWER CHANNEL
Rx
DATA + POWER CHANNEL
Tx

FIG. 8A

FIG. 8B


DATA
DATA
620
630
630
636
634
632
640
640
+V
TO / FROM FILTER
-V
+V
TO / FROM FILTER
-V
-V
+V
-V
+V
DATA +POWER CHANNEL
DATA +POWER CHANNEL

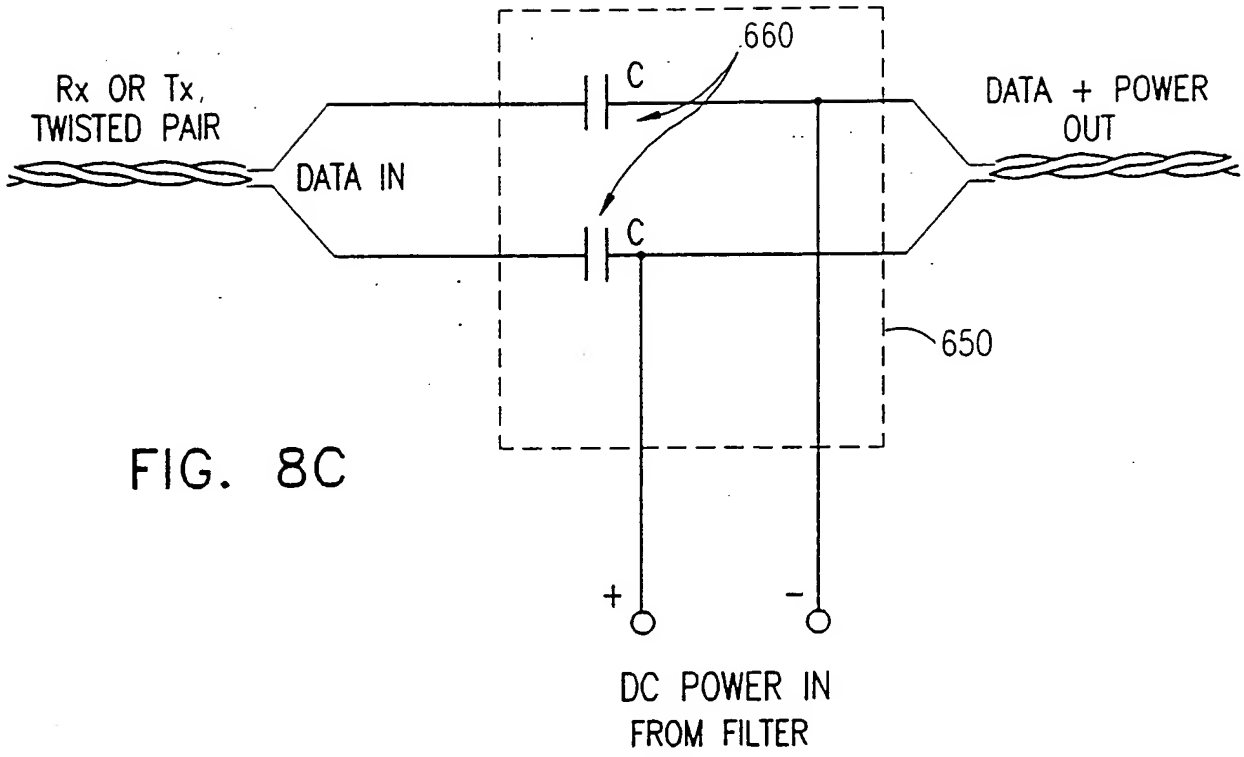

660
C
Rx OR Tx,
TWISTED PAIR
DATA IN
C
DATA + POWER
OUT
650
+
-
DC POWER IN
FROM FILTER

FIG. 8C

FIG. 8D

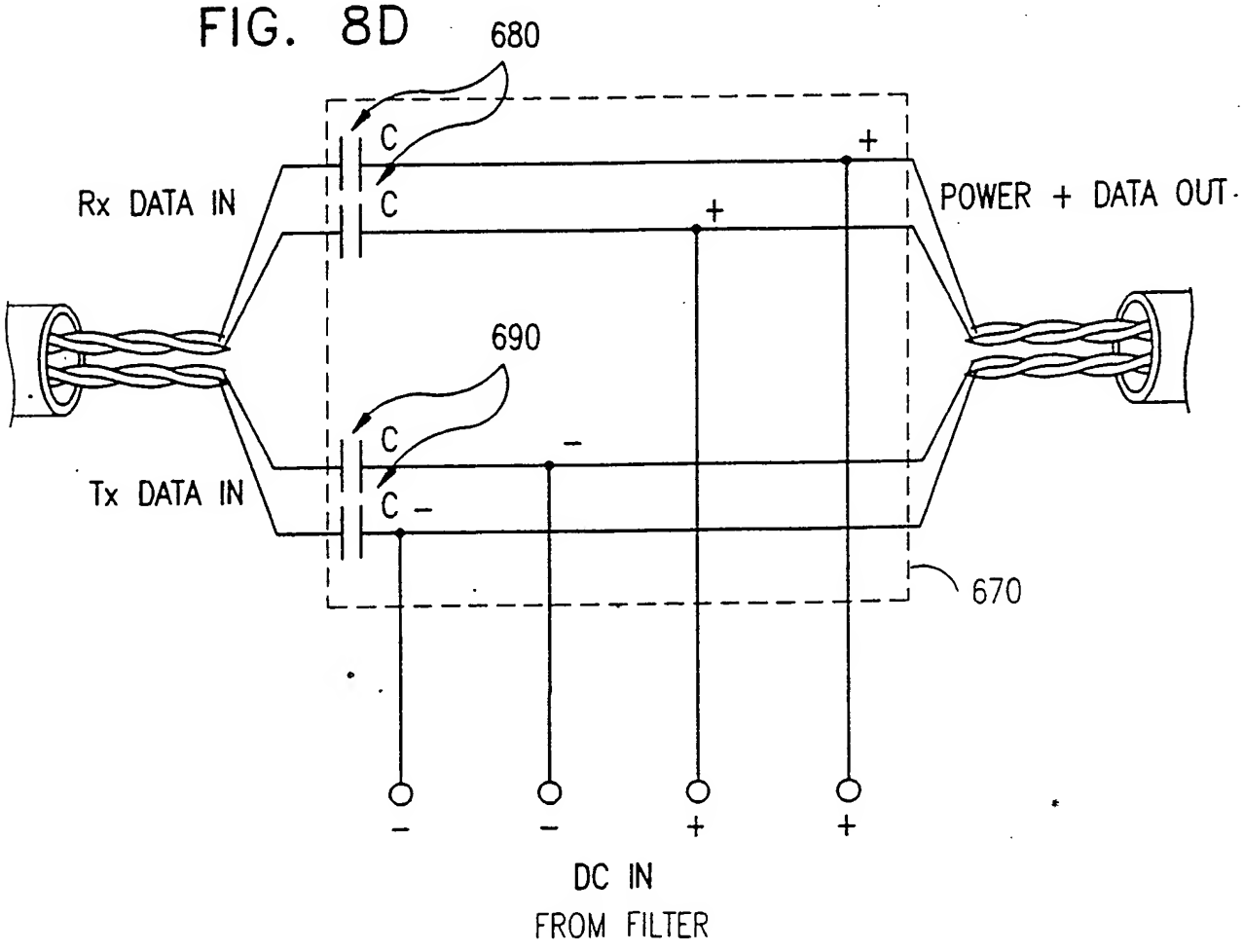
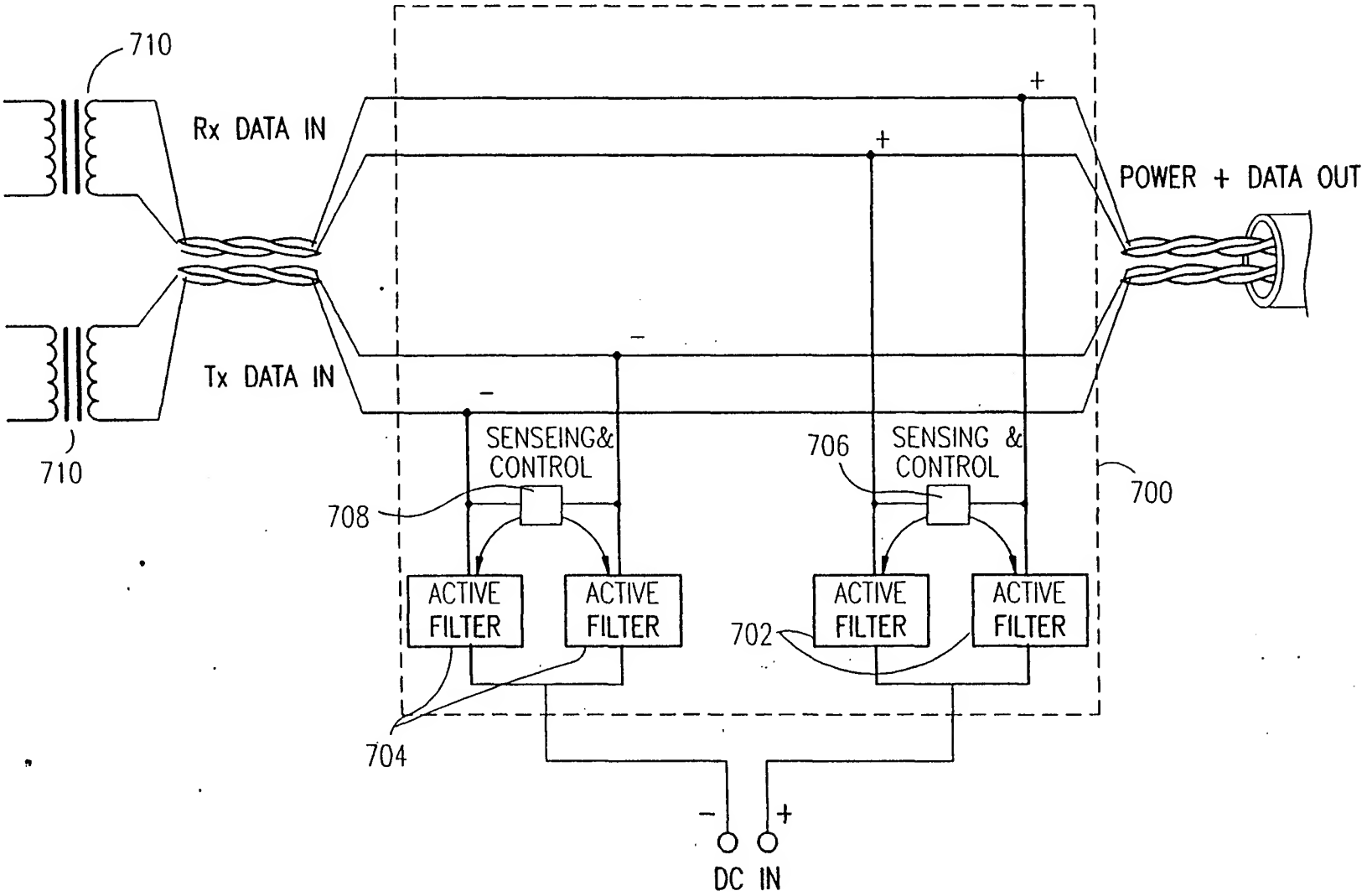

680
C
C
+
+
Rx DATA IN
POWER + DATA OUT
690
C
-
C
-
Tx DATA IN
670
-
-
+
+
DC IN
FROM FILTER

FIG. 8E


710
Rx DATA IN
Tx DATA IN
710
+
+
POWER + DATA OUT
–
–
SENSEING&
CONTROL
708
706
SENSING &
CONTROL
700
ACTIVE
FILTER
ACTIVE
FILTER
ACTIVE
FILTER
ACTIVE
FILTER
702
704
–
+
DC IN

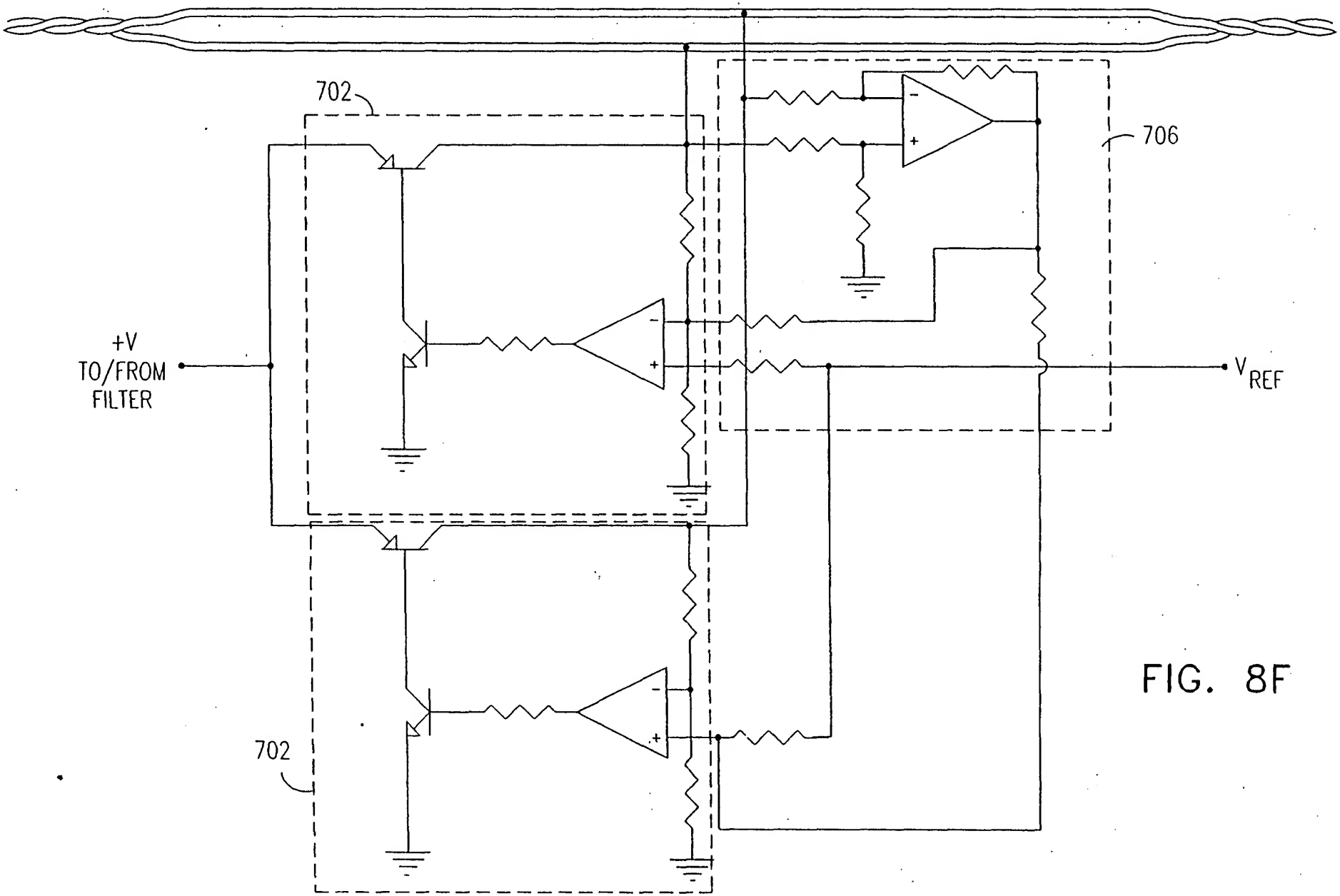


FIG. 8F

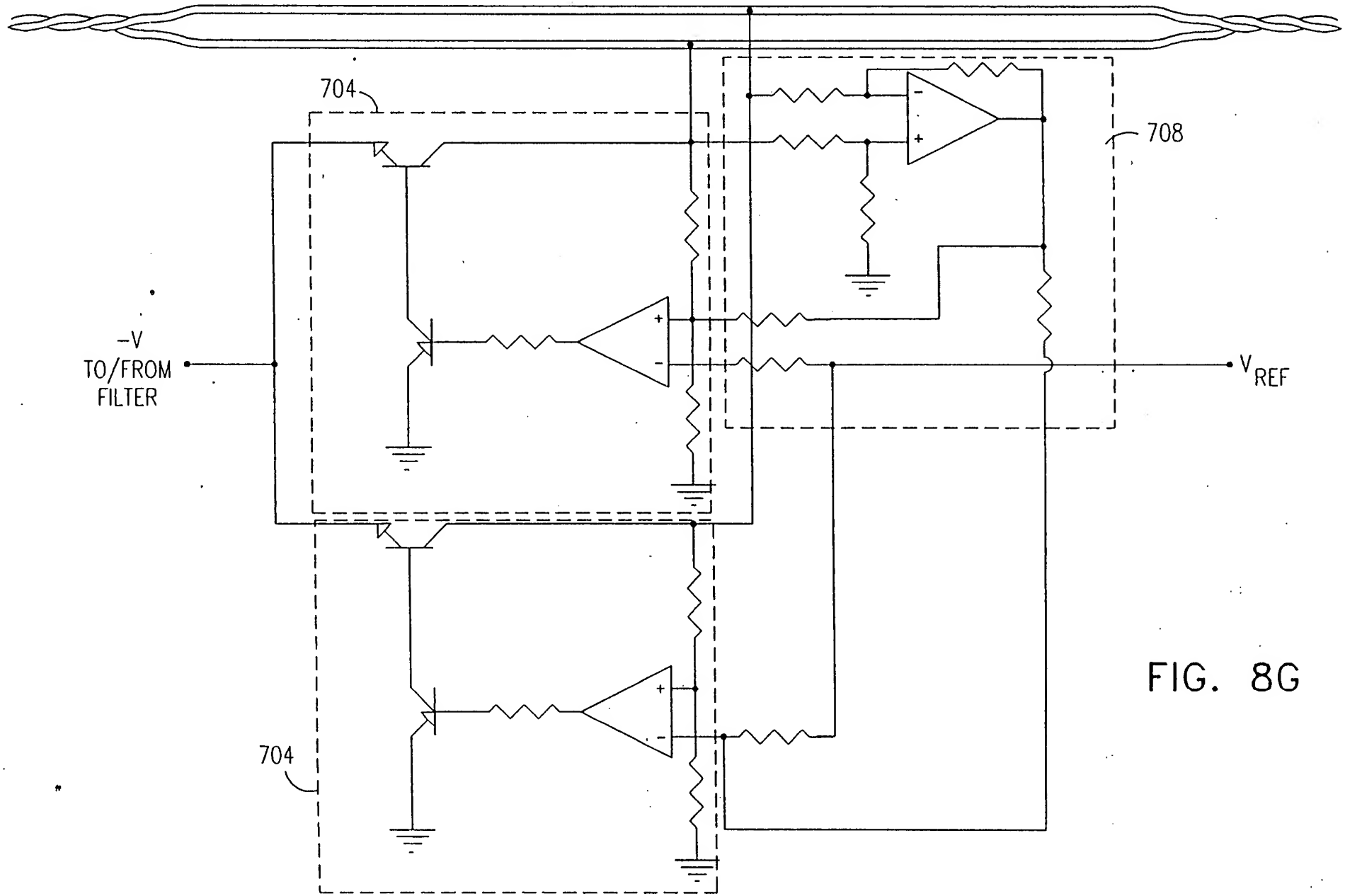


FIG. 8G

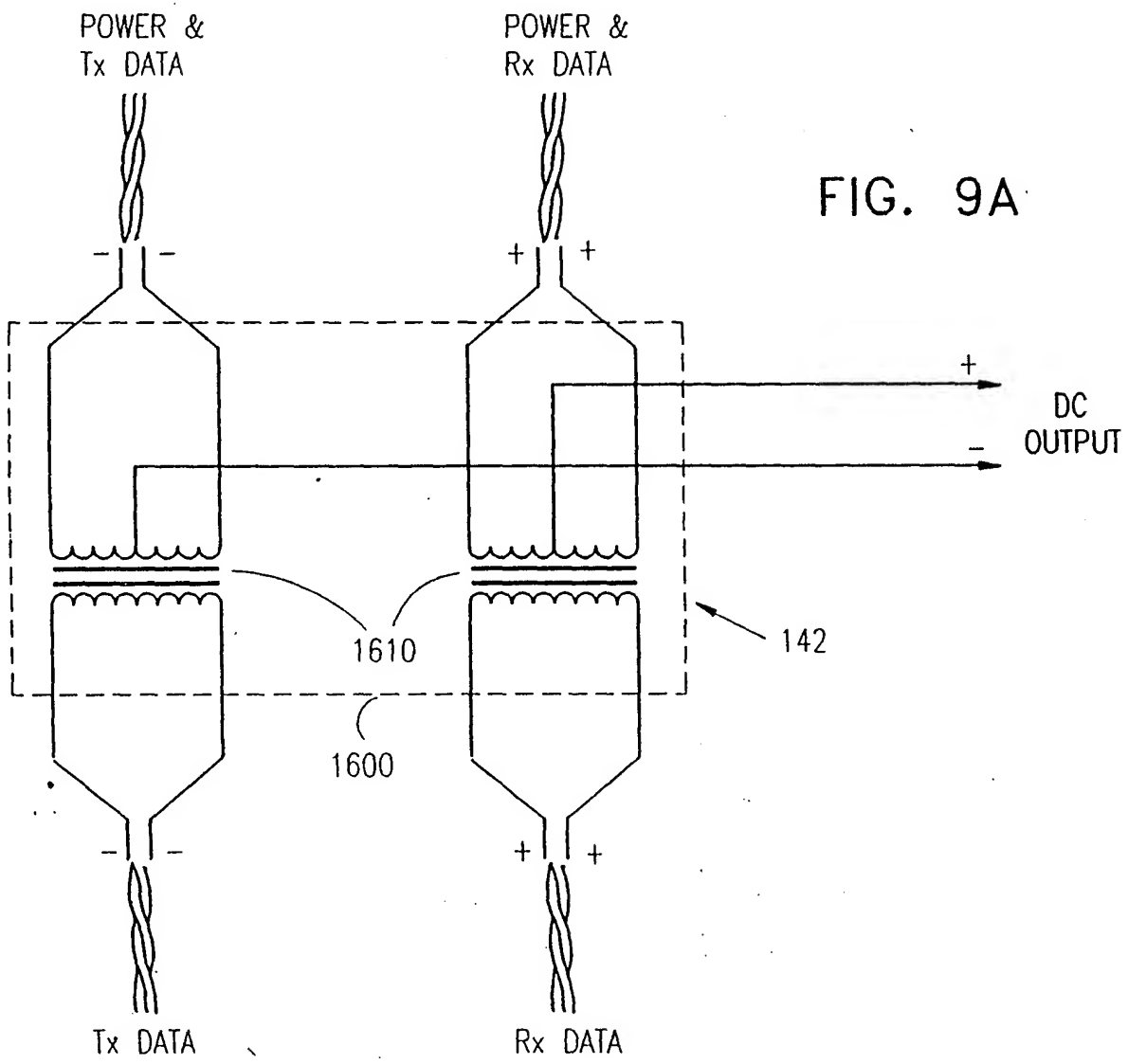

POWER &
Tx DATA
POWER &
Rx DATA
+
DC
OUTPUT
–
1610
142
1600
Tx DATA
Rx DATA

FIG. 9A

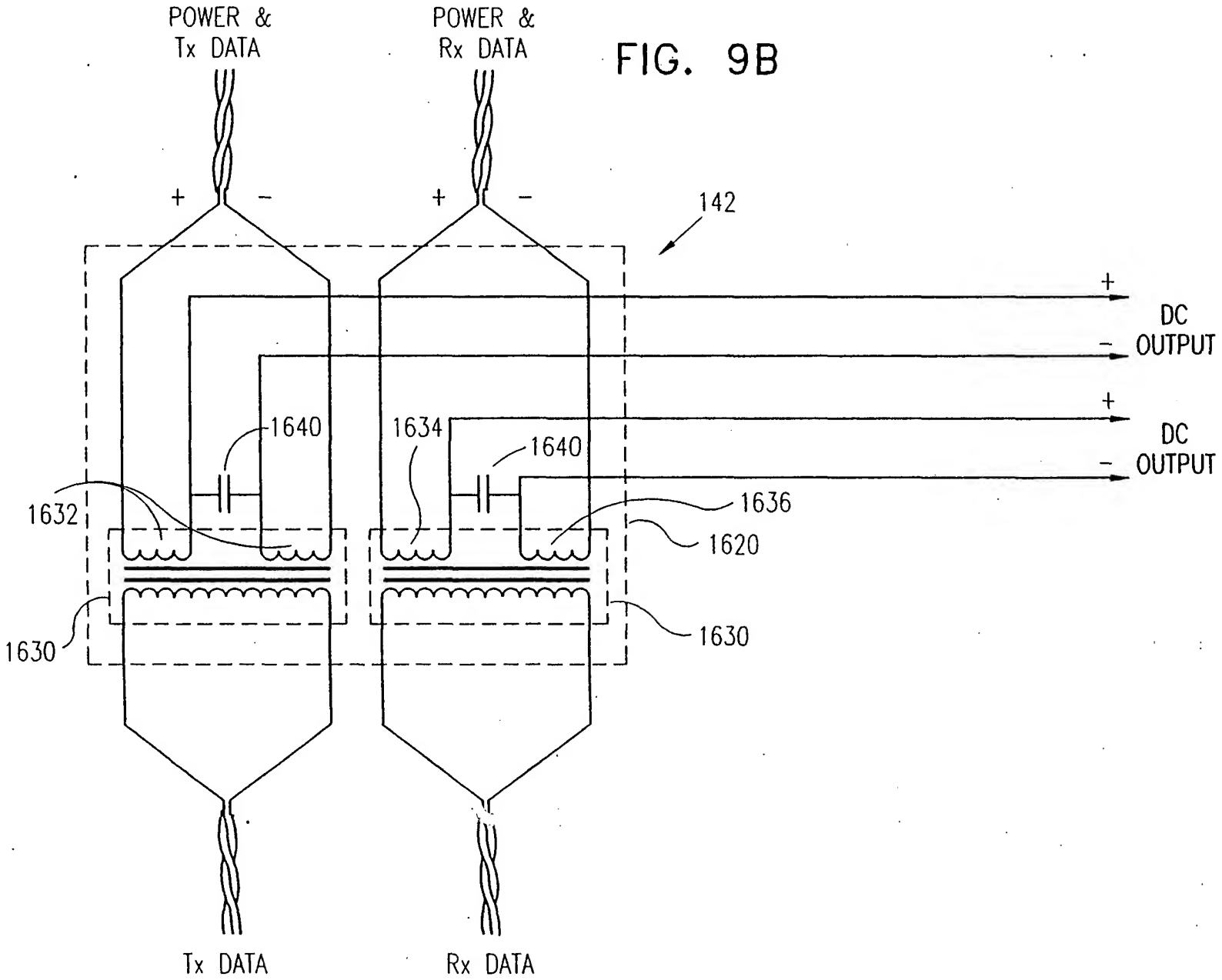

POWER &
Tx DATA
POWER &
Rx DATA
+
−
+
−
142
+
DC
−
OUTPUT
+
DC
−
OUTPUT
1640
1634
1640
1632
1636
1620
1630
1630
Tx DATA
Rx DATA

FIG. 9B

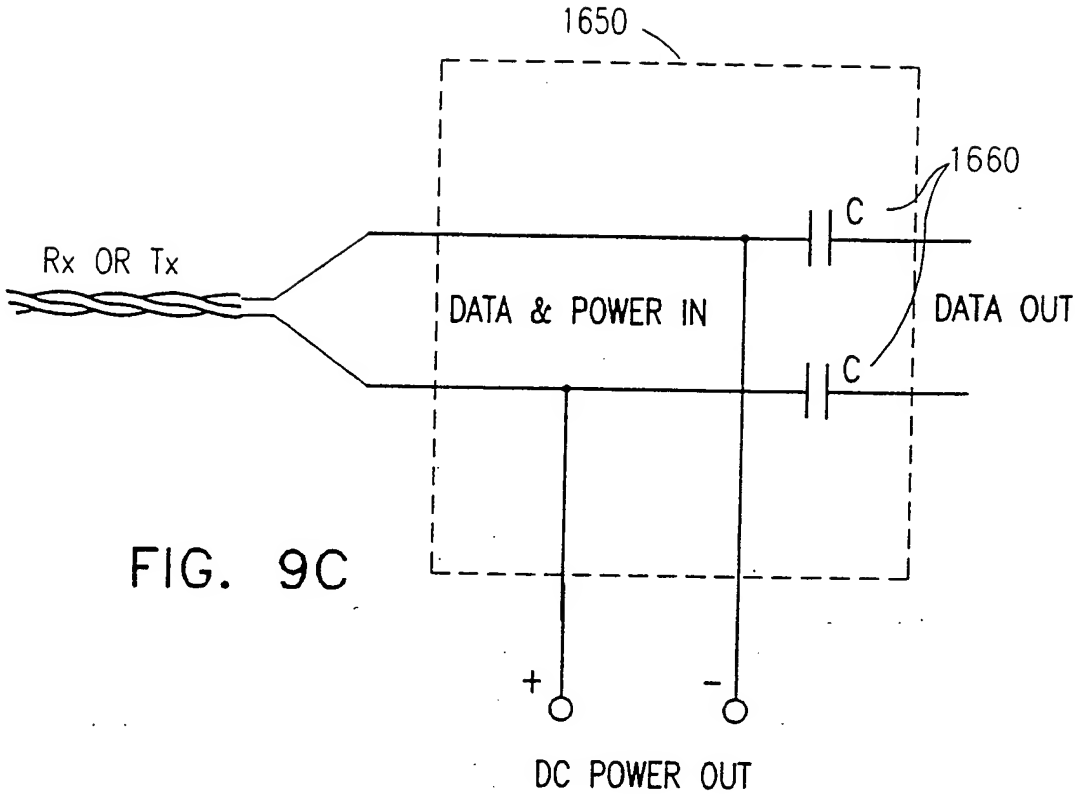


FIG. 9C

FIG. 9D

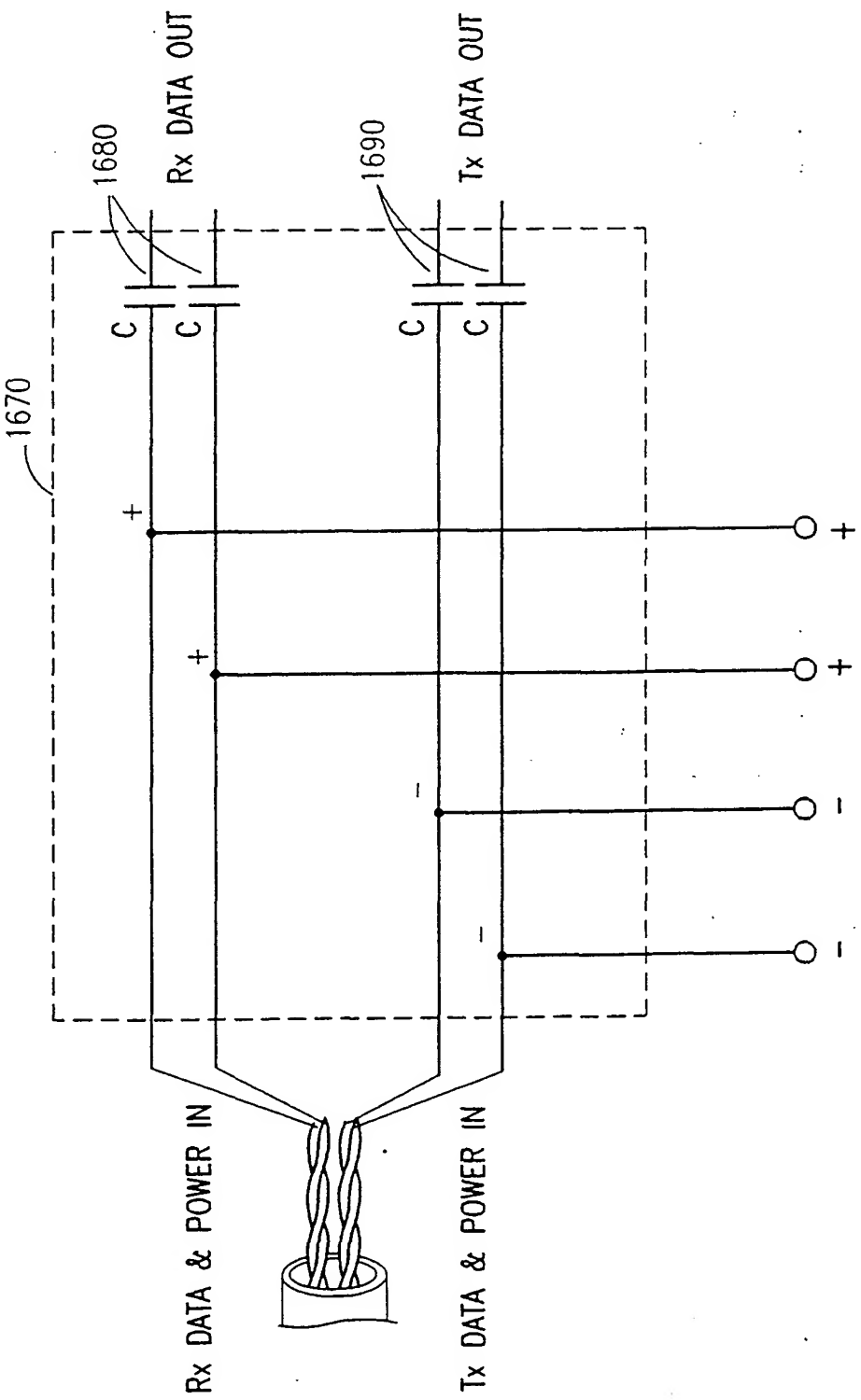
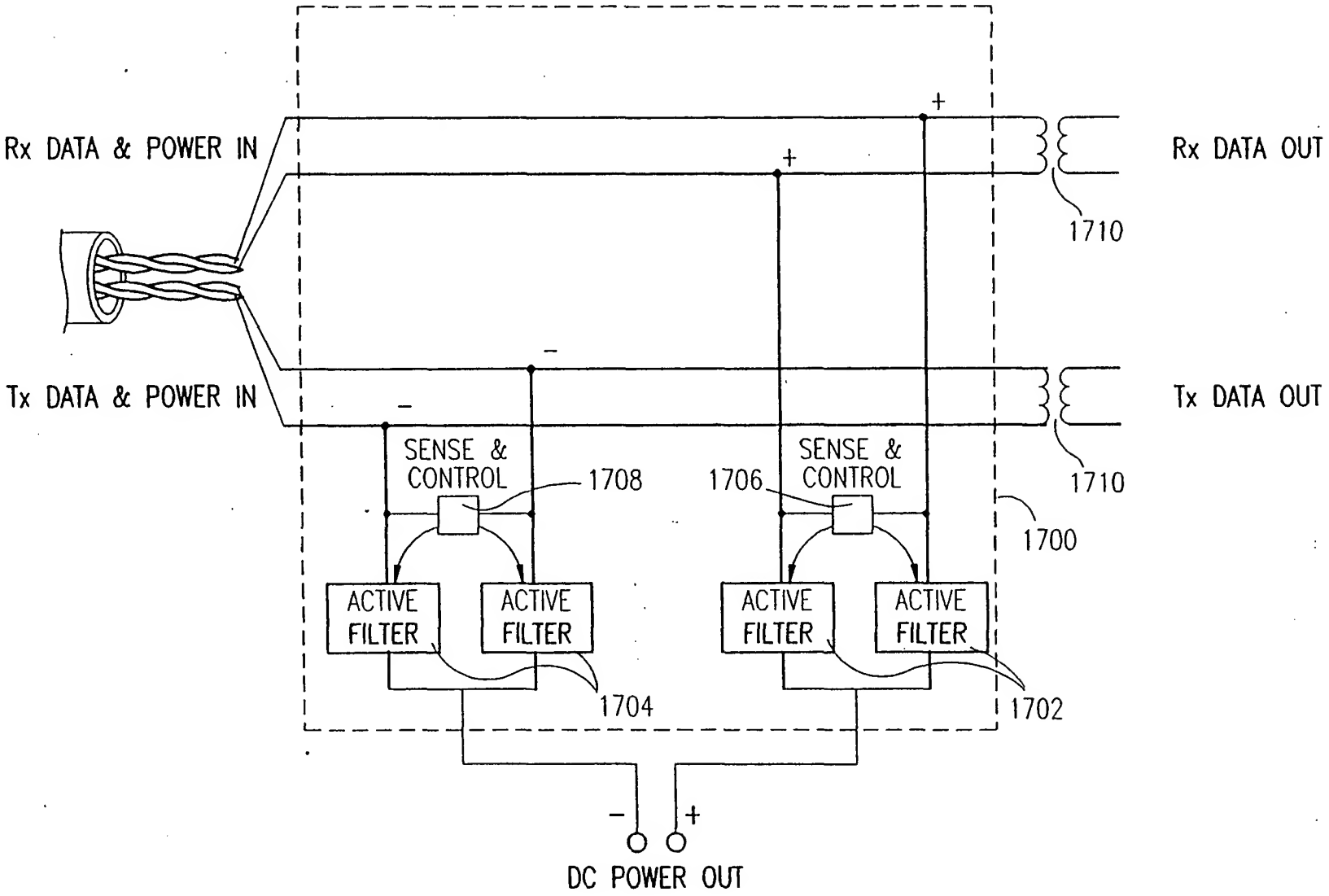

1670
1680
Rx DATA OUT
1690
Tx DATA OUT
C
C
C
C
+
+
-
-
+
+
-
-
DC POWER OUT
Rx DATA & POWER IN
Tx DATA & POWER IN

FIG. 9E


Rx DATA & POWER IN
Tx DATA & POWER IN
Rx DATA OUT
Tx DATA OUT
1710
1710
+
+
–
–
SENSE & CONTROL
1708
1706
SENSE & CONTROL
1700
ACTIVE FILTER
ACTIVE FILTER
ACTIVE FILTER
ACTIVE FILTER
1704
1702
–
+
DC POWER OUT

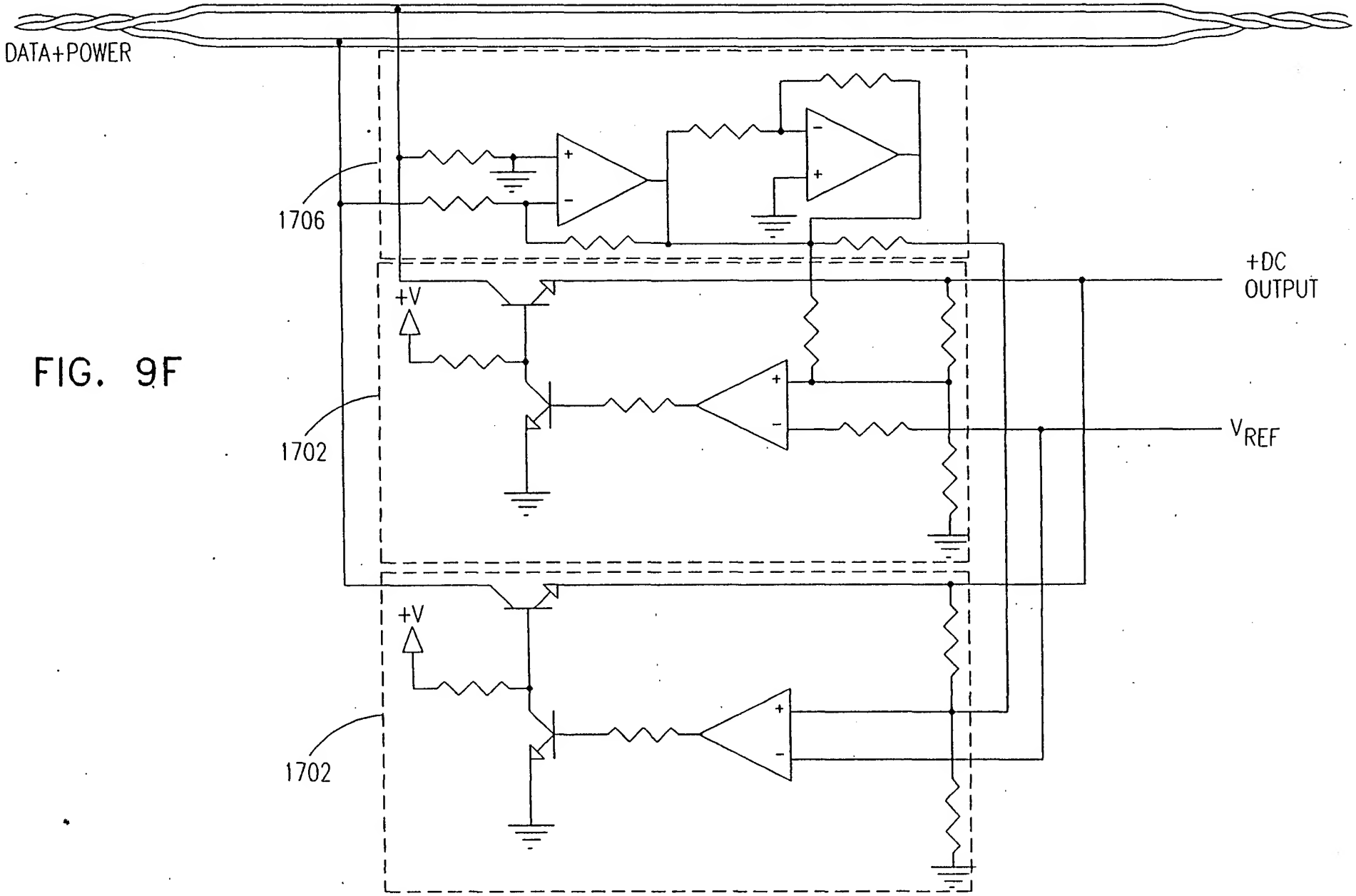


FIG. 9F

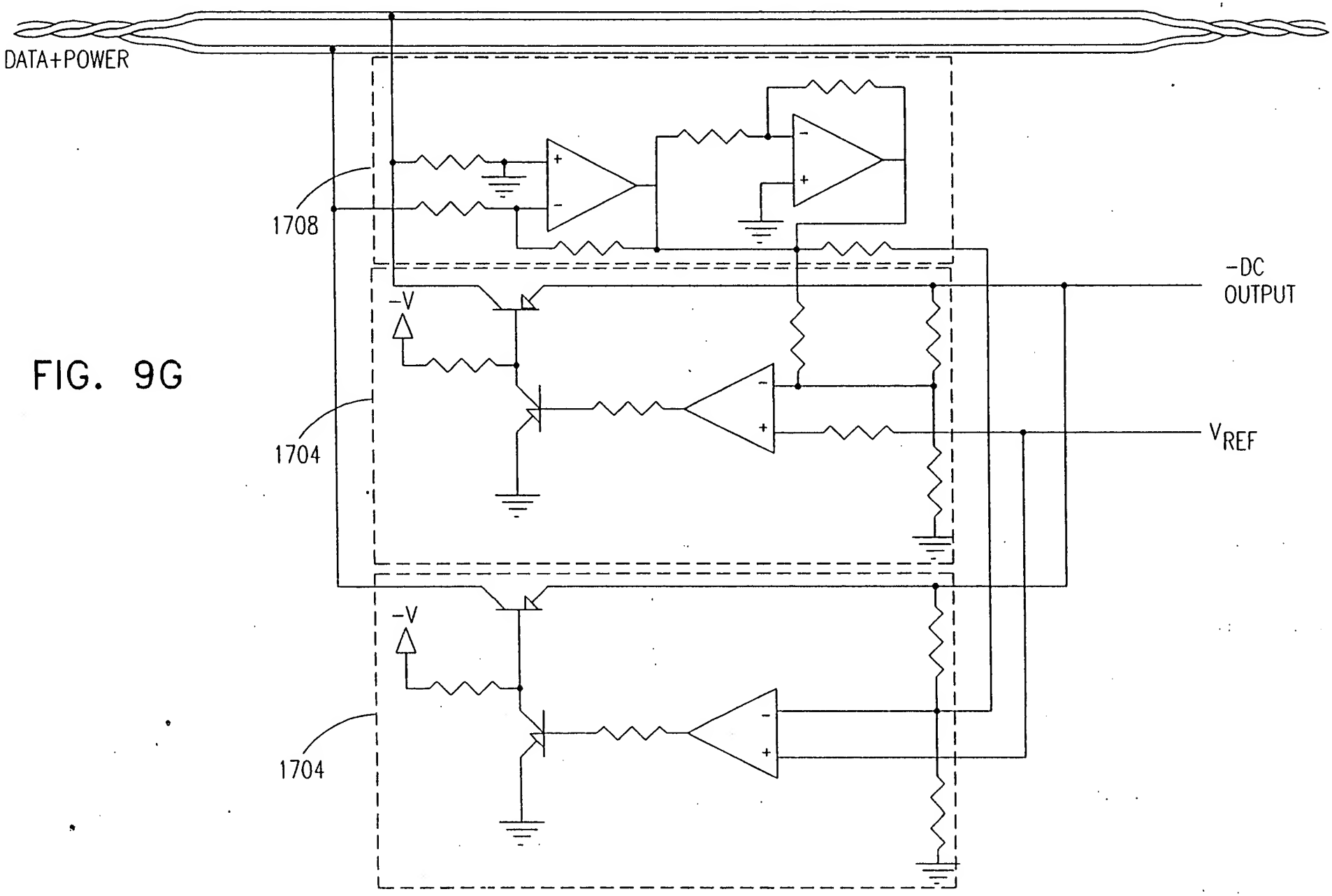


FIG. 9G

FIG. 10A

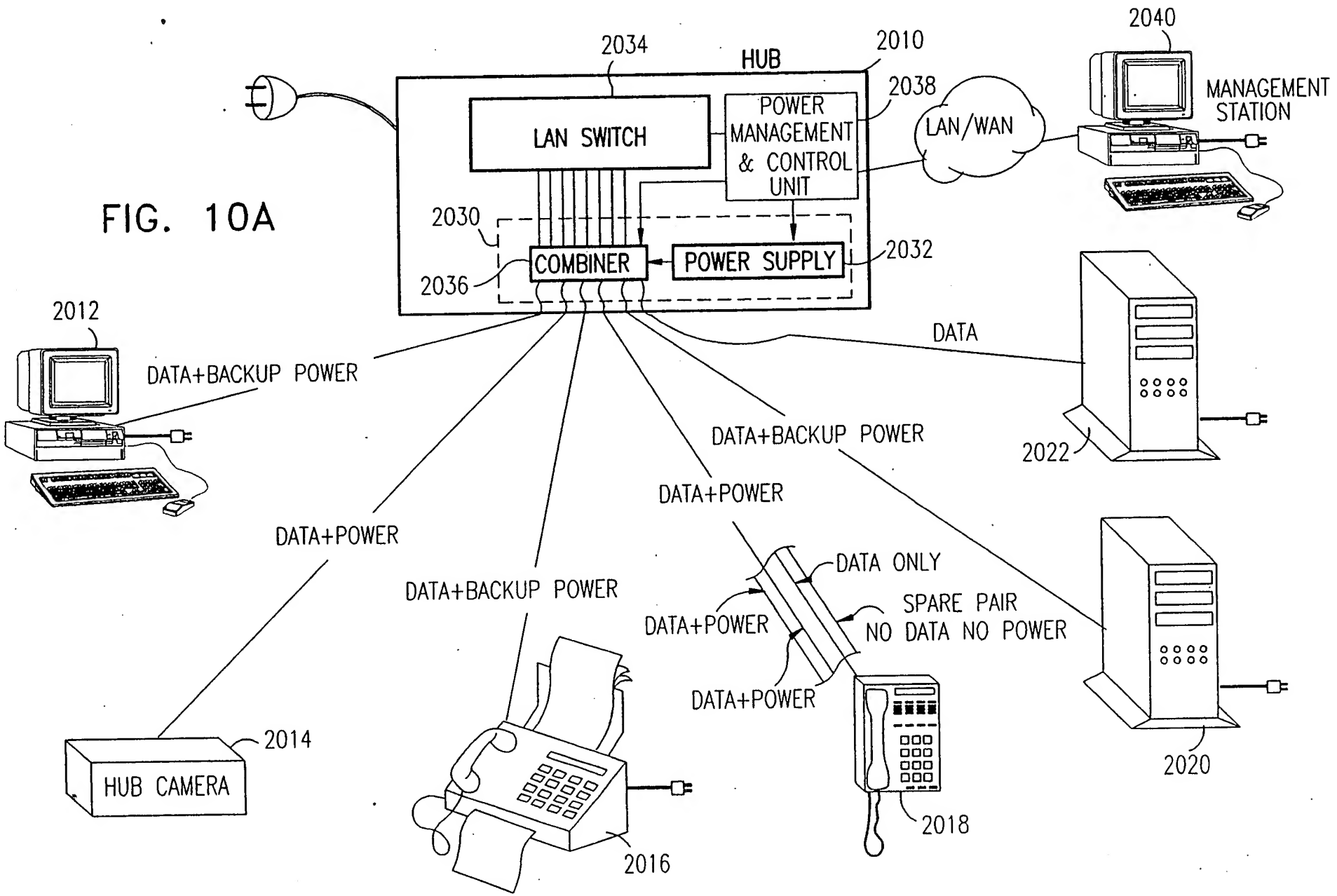

2034
HUB
2010
2040
LAN SWITCH
POWER MANAGEMENT & CONTROL UNIT
2038
LAN/WAN
MANAGEMENT STATION
2030
COMBINER
POWER SUPPLY
2032
2036
2012
DATA
DATA+BACKUP POWER
DATA+BACKUP POWER
2022
DATA+POWER
DATA+POWER
DATA ONLY
SPARE PAIR
NO DATA NO POWER
DATA+BACKUP POWER
DATA+POWER
2014
HUB CAMERA
2016
2018
2020

FIG. 10B

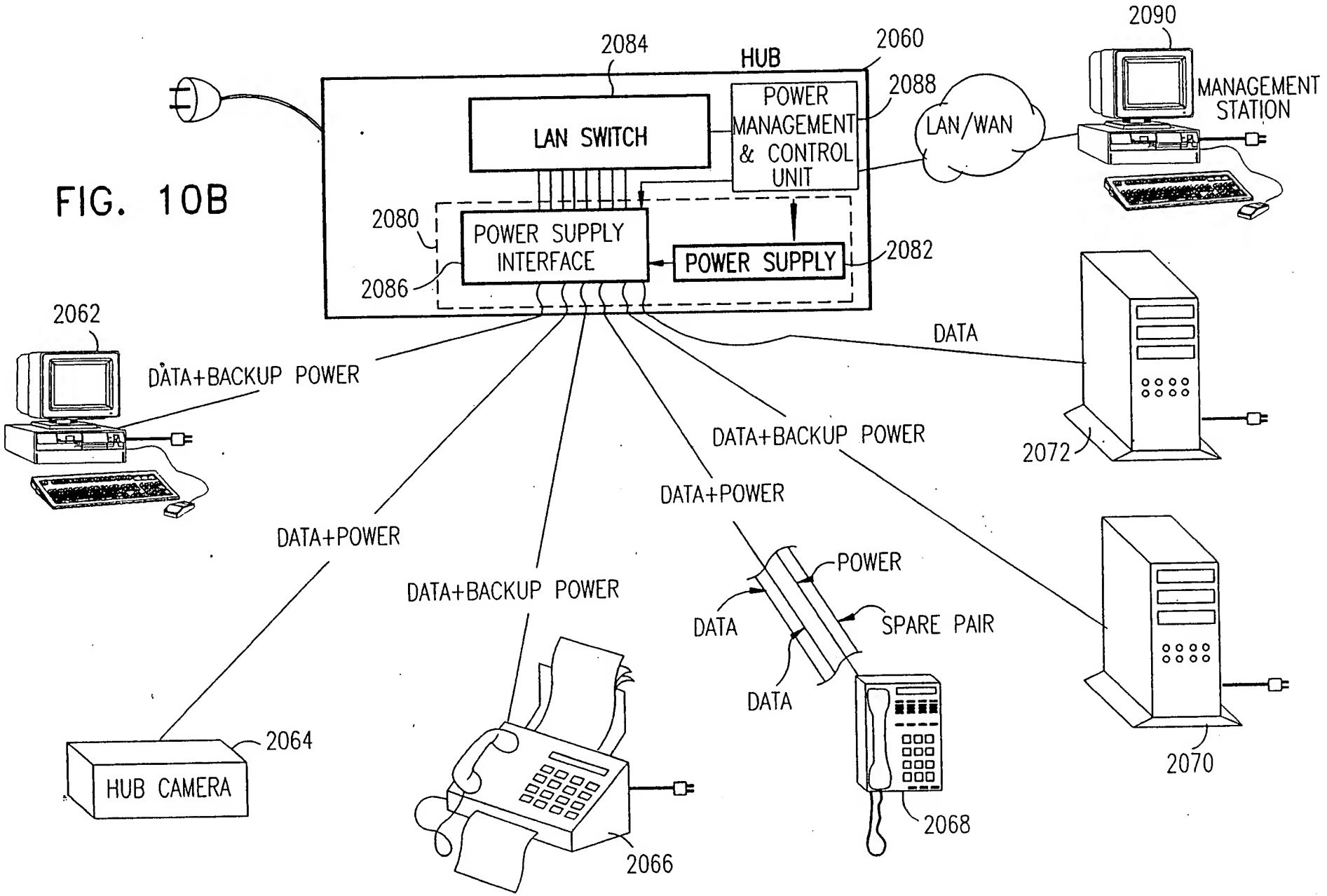

2084
HUB
2060
2088
LAN SWITCH
POWER MANAGEMENT & CONTROL UNIT
LAN/WAN
2090
MANAGEMENT STATION
2080
POWER SUPPLY INTERFACE
2086
POWER SUPPLY
2082
2062
DATA+BACKUP POWER
DATA
2072
DATA+BACKUP POWER
DATA+POWER
DATA+POWER
DATA+BACKUP POWER
POWER
DATA
SPARE PAIR
DATA
2064
HUB CAMERA
2066
2068
2070

FIG. 11A

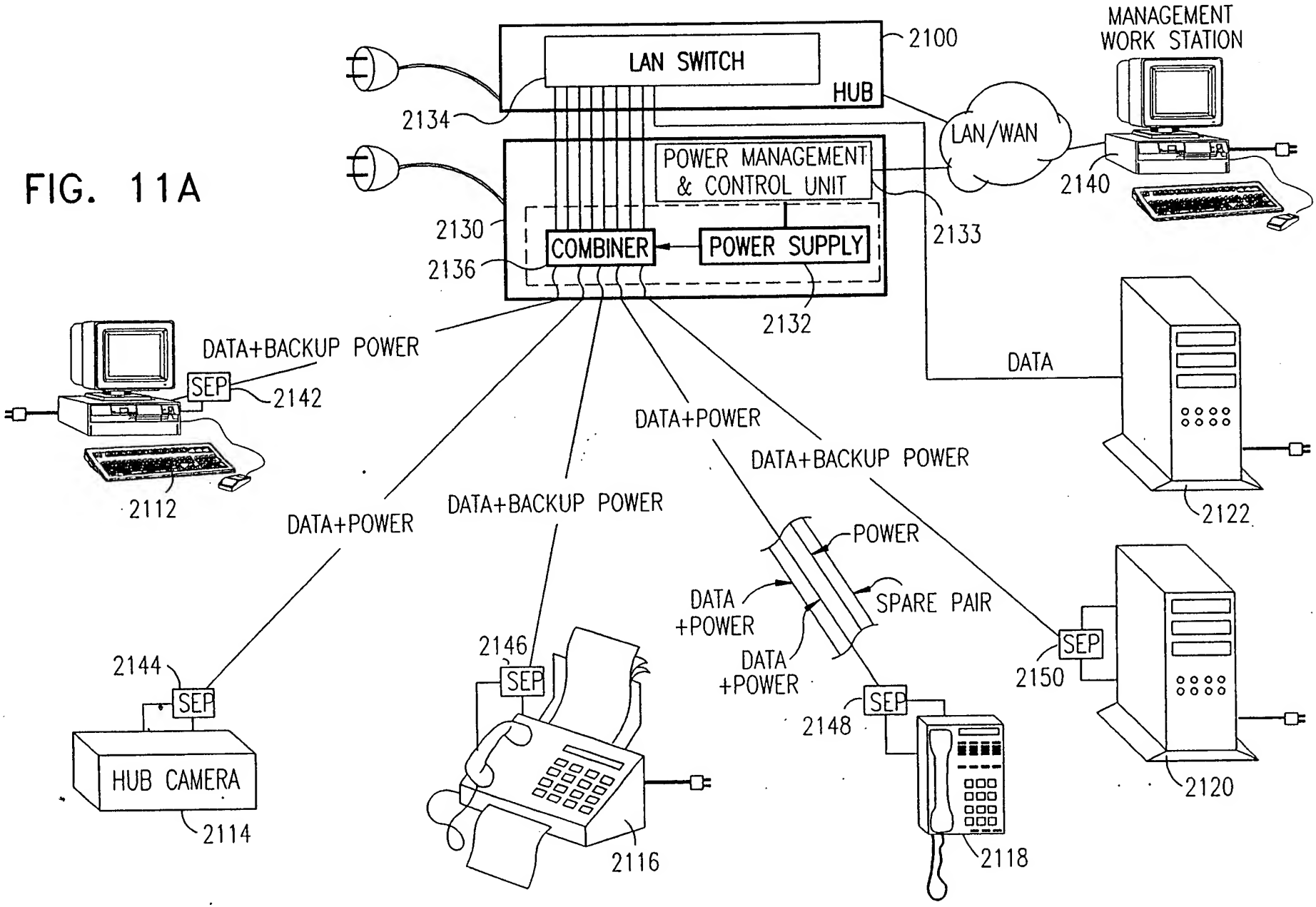

LAN SWITCH
HUB
2100
2134
POWER MANAGEMENT & CONTROL UNIT
2130
COMBINER
POWER SUPPLY
2136
2132
2133
LAN/WAN
MANAGEMENT WORK STATION
2140
DATA+BACKUP POWER
SEP
2142
2112
DATA
2122
DATA+POWER
DATA+BACKUP POWER
DATA+POWER
DATA+BACKUP POWER
POWER
DATA +POWER
SPARE PAIR
DATA +POWER
2144
SEP
HUB CAMERA
2114
2146
SEP
2116
SEP
2148
2118
SEP
2150
2120

FIG. 11B

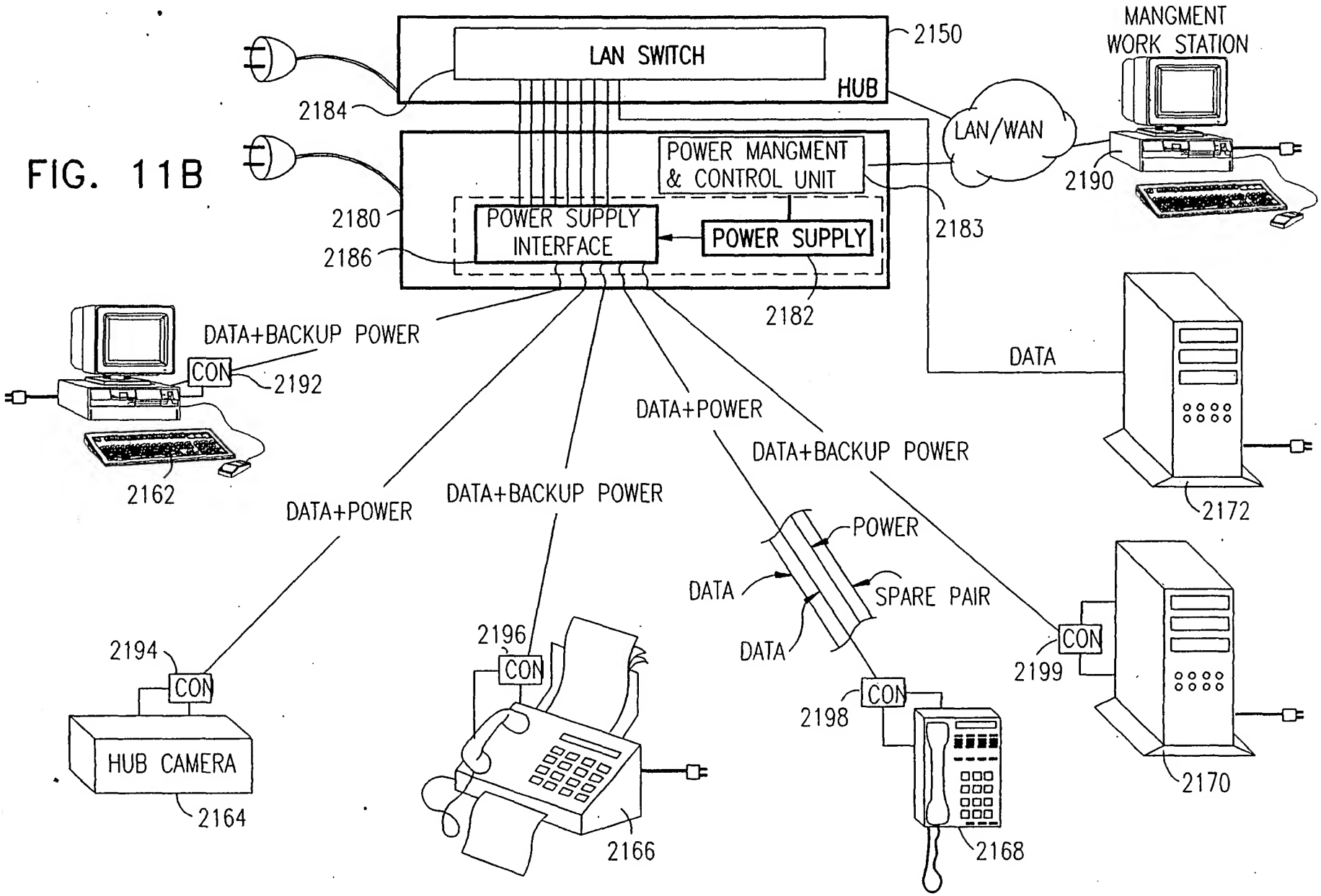

LAN SWITCH
HUB
2150
2184
MANGMENT
WORK STATION
LAN/WAN
2190
POWER MANGMENT
& CONTROL UNIT
2183
2180
POWER SUPPLY
INTERFACE
POWER SUPPLY
2186
2182
DATA+BACKUP POWER
CON
2192
2162
DATA
2172
DATA+POWER
DATA+BACKUP POWER
DATA+POWER
DATA+BACKUP POWER
POWER
DATA
SPARE PAIR
DATA
2194
CON
HUB CAMERA
2164
2196
CON
2166
CON
2198
2168
CON
2199
2170

FIG. 12A

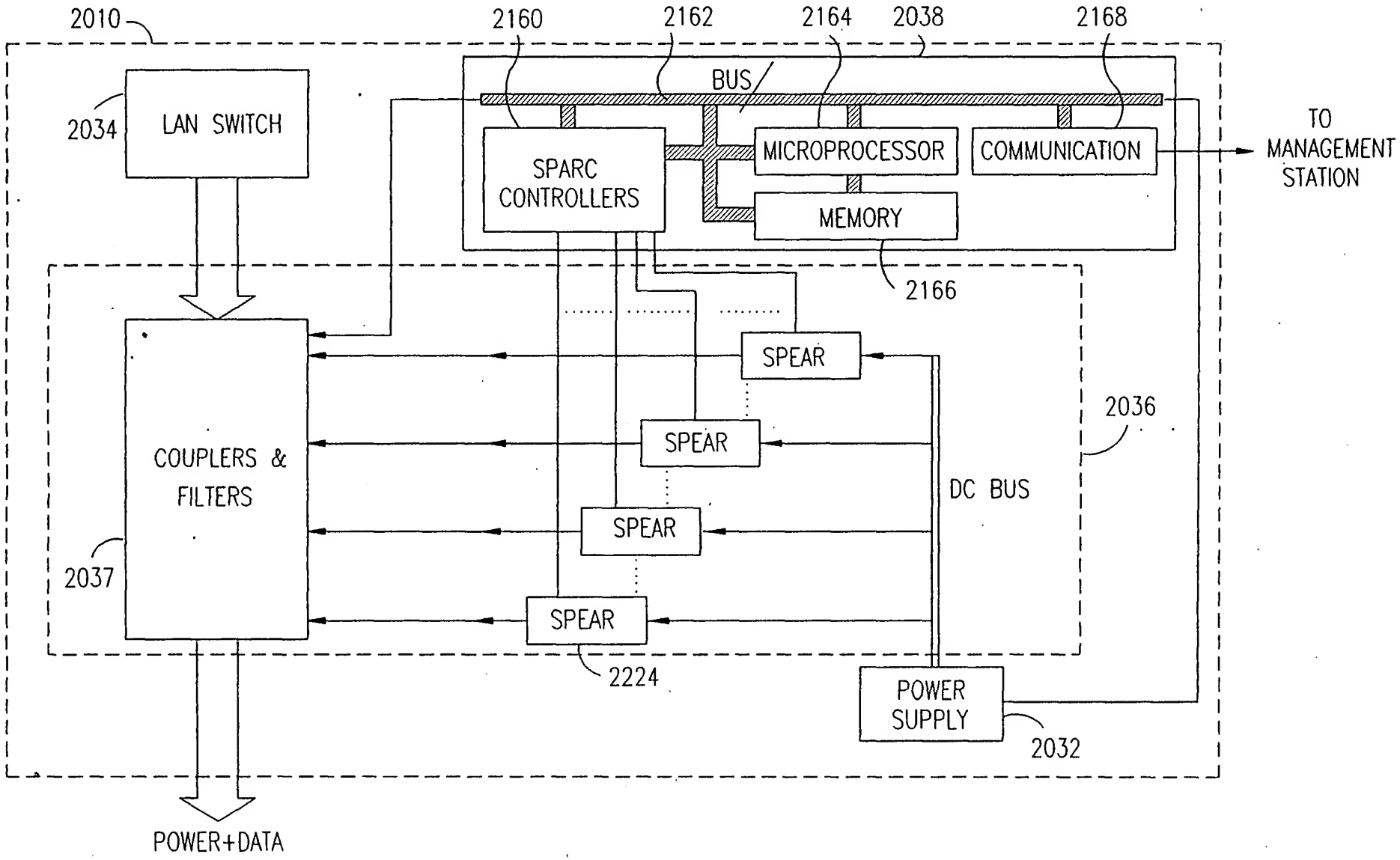

2010
2160
2162
2164
2038
2168
BUS
2034
LAN SWITCH
SPARC CONTROLLERS
MICROPROCESSOR
COMMUNICATION
MEMORY
TO MANAGEMENT STATION
2166
SPEAR
SPEAR
SPEAR
SPEAR
2036
COUPLERS & FILTERS
2037
DC BUS
2224
POWER SUPPLY
2032
POWER+DATA

FIG. 12B

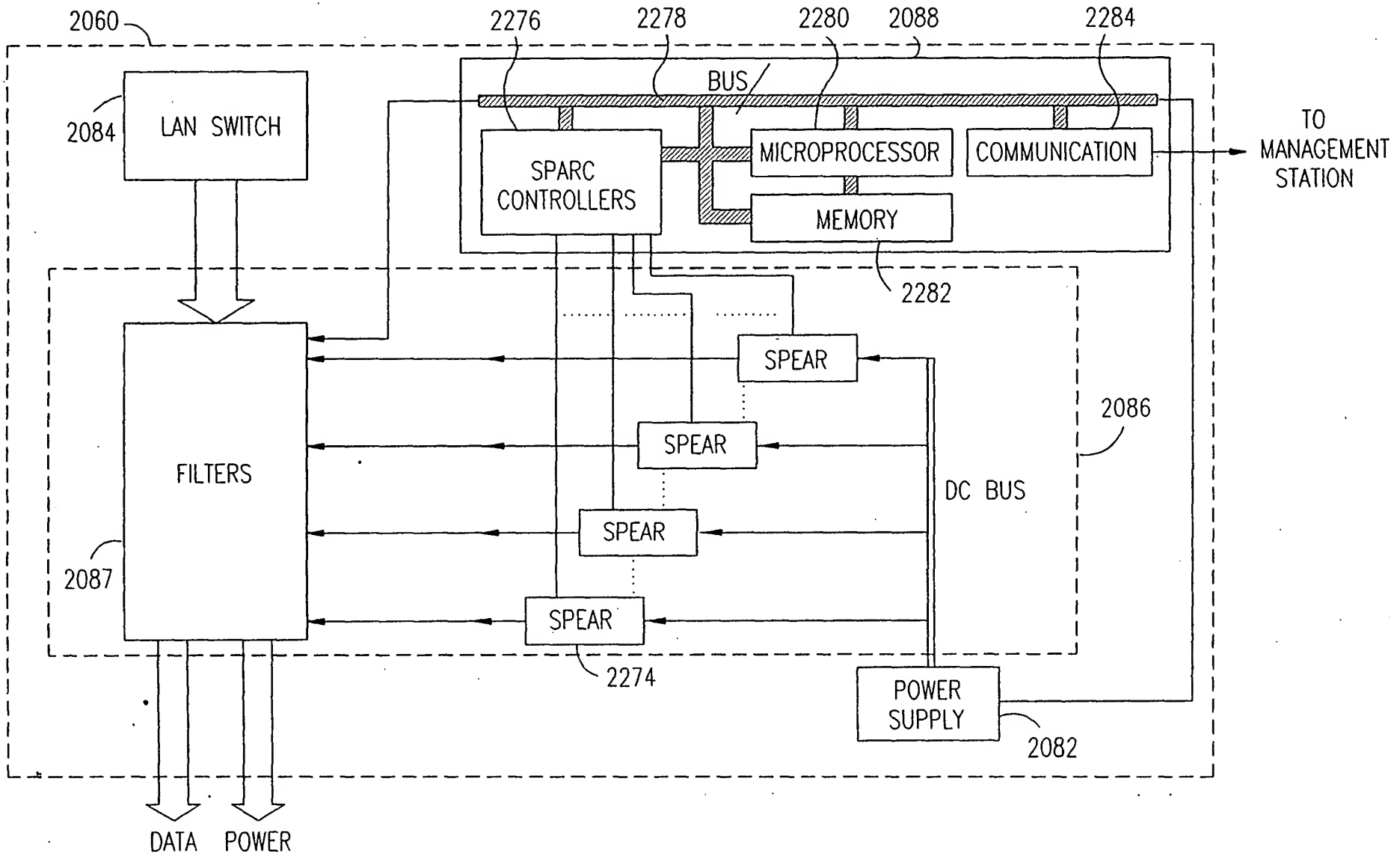

2060
2276
2278
2280
2088
2284
BUS
2084
LAN SWITCH
SPARC CONTROLLERS
MICROPROCESSOR
COMMUNICATION
TO MANAGEMENT STATION
MEMORY
2282
SPEAR
SPEAR
SPEAR
SPEAR
2086
FILTERS
DC BUS
2087
2274
POWER SUPPLY
2082
DATA
POWER

FIG. 13A

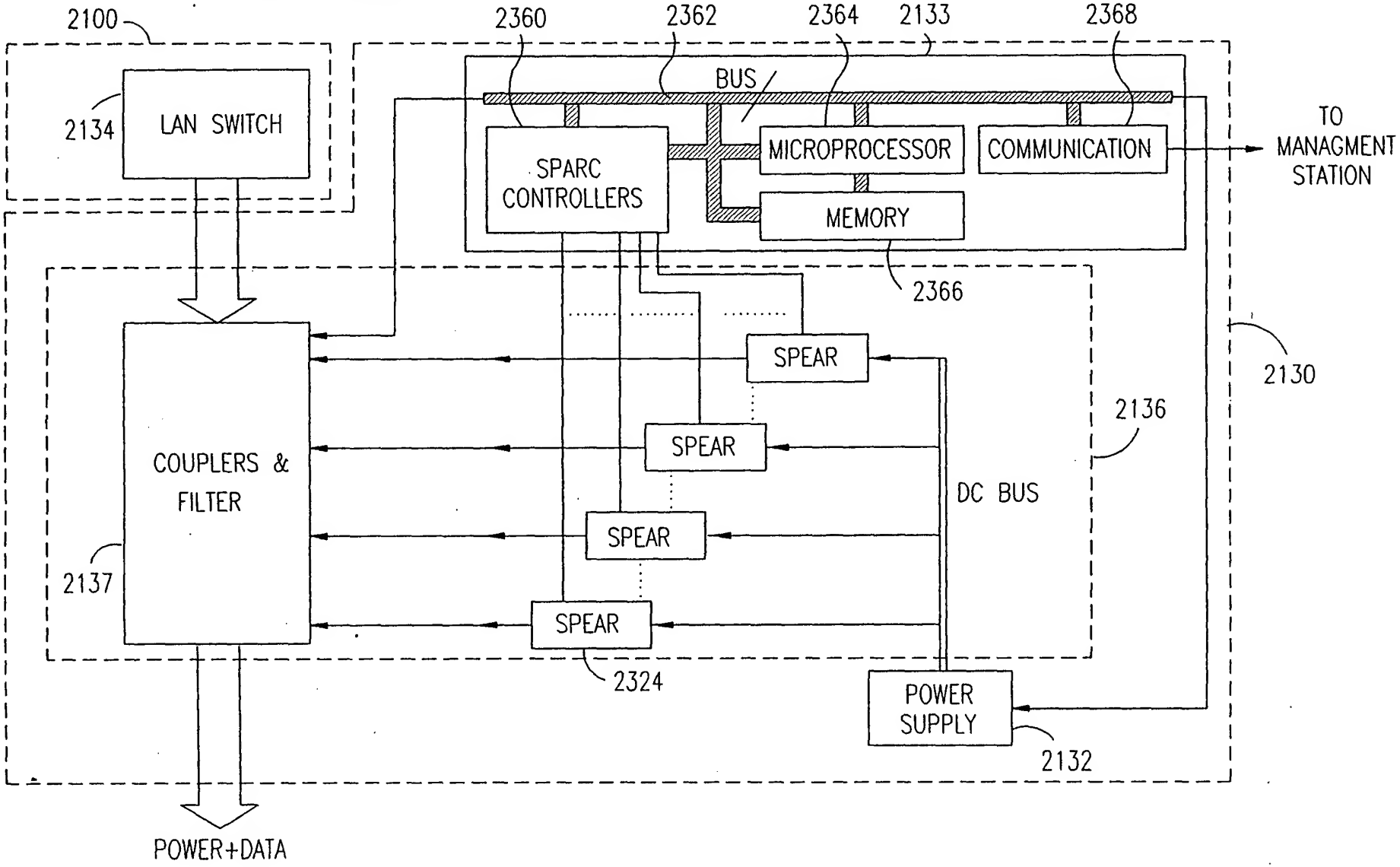
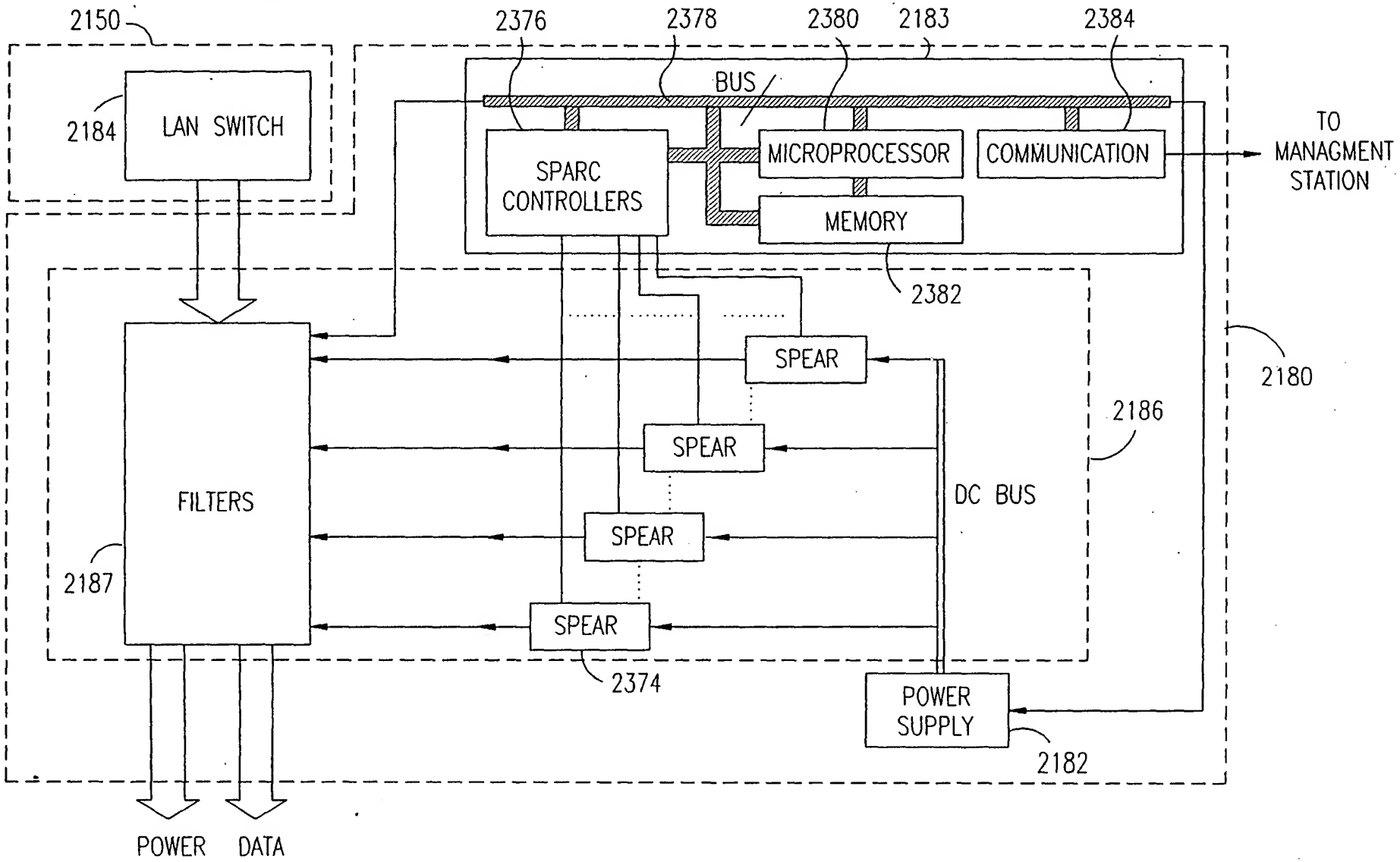

2100
2360
2362
2364
2133
2368
BUS
2134
LAN SWITCH
SPARC CONTROLLERS
MICROPROCESSOR
COMMUNICATION
TO MANAGMENT STATION
MEMORY
2366
SPEAR
2130
2136
SPEAR
COUPLERS & FILTER
DC BUS
SPEAR
2137
SPEAR
2324
POWER SUPPLY
2132
POWER+DATA

FIG. 13B


2150
2376
2378
2380
2183
2384
BUS
2184
LAN SWITCH
SPARC CONTROLLERS
MICROPROCESSOR
COMMUNICATION
TO MANAGMENT STATION
MEMORY
2382
SPEAR
2180
2186
SPEAR
FILTERS
DC BUS
SPEAR
2187
SPEAR
2374
POWER SUPPLY
2182
POWER
DATA

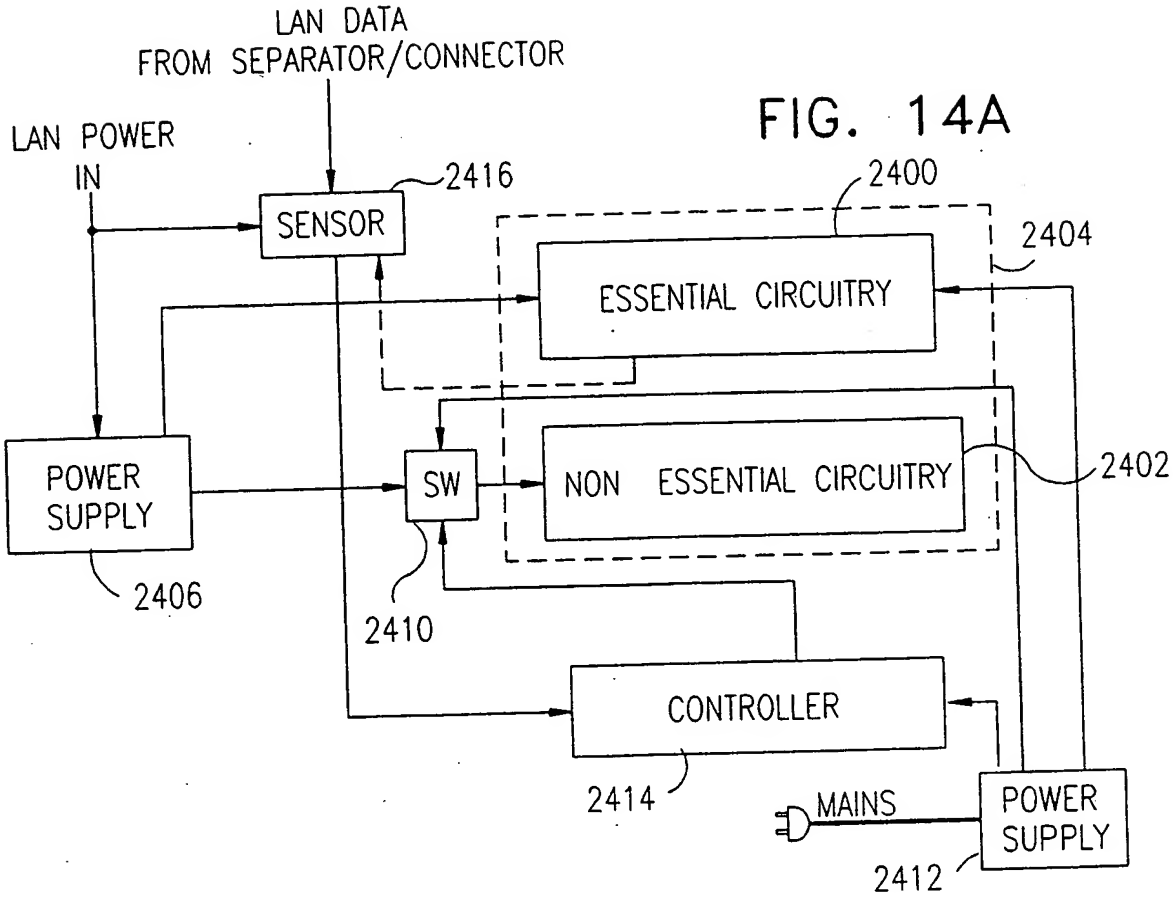


FIG. 14A

FIG. 14B

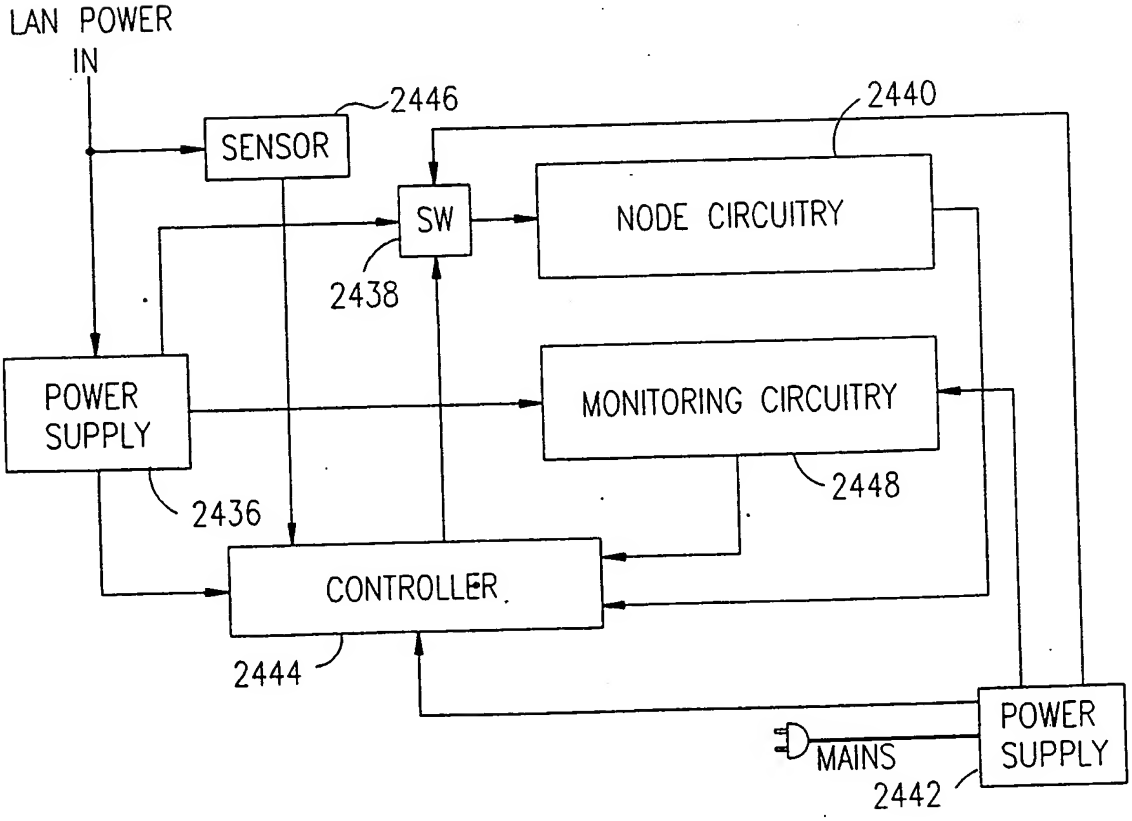


FIG. 15

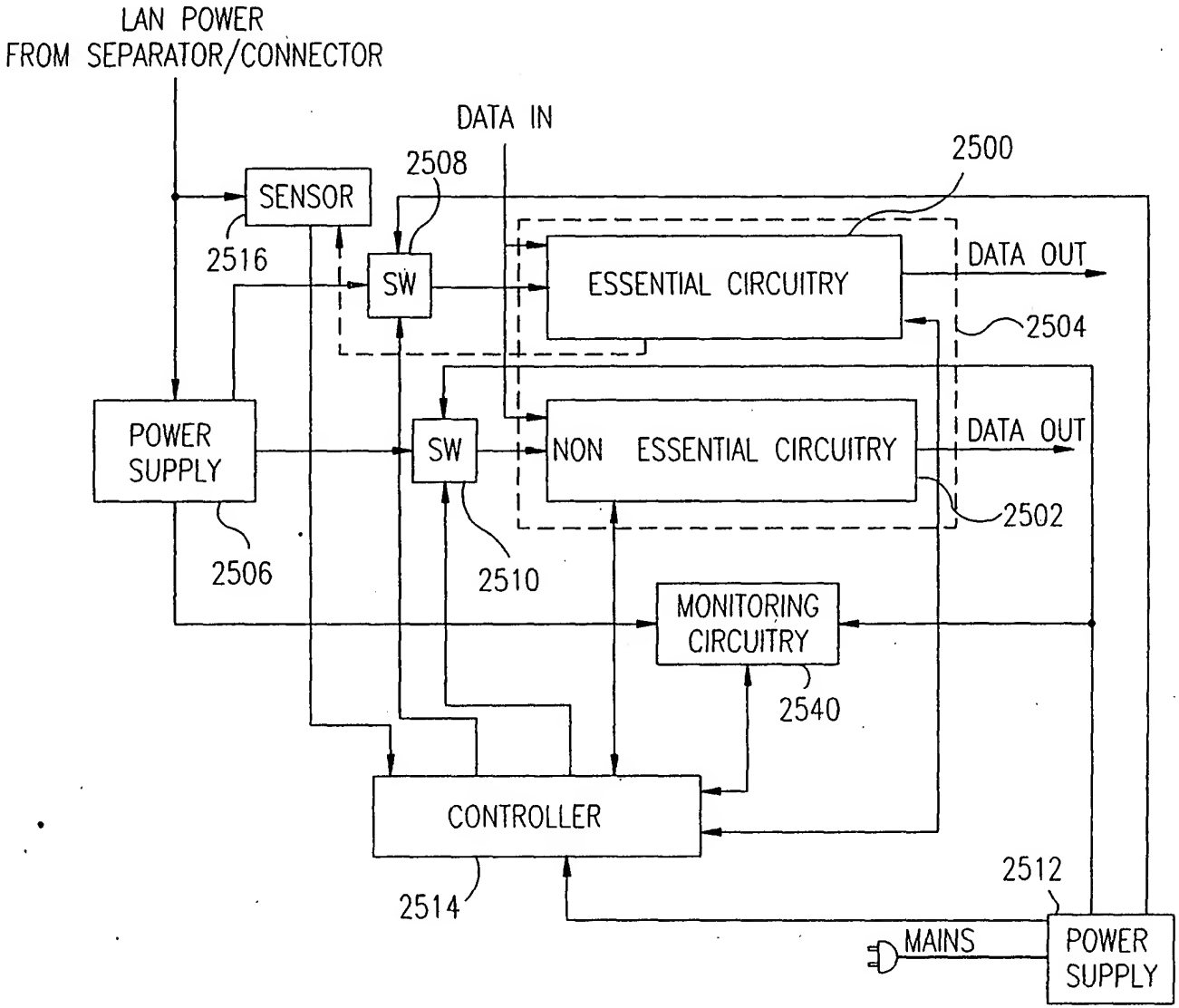

LAN POWER
FROM SEPARATOR/CONNECTOR
DATA IN
2508
2500
SENSOR
2516
SW
ESSENTIAL CIRCUITRY
DATA OUT
2504
POWER
SUPPLY
SW
NON ESSENTIAL CIRCUITRY
DATA OUT
2502
2506
2510
MONITORING
CIRCUITRY
2540
CONTROLLER
2514
2512
MAINS
POWER
SUPPLY

FIG. 16

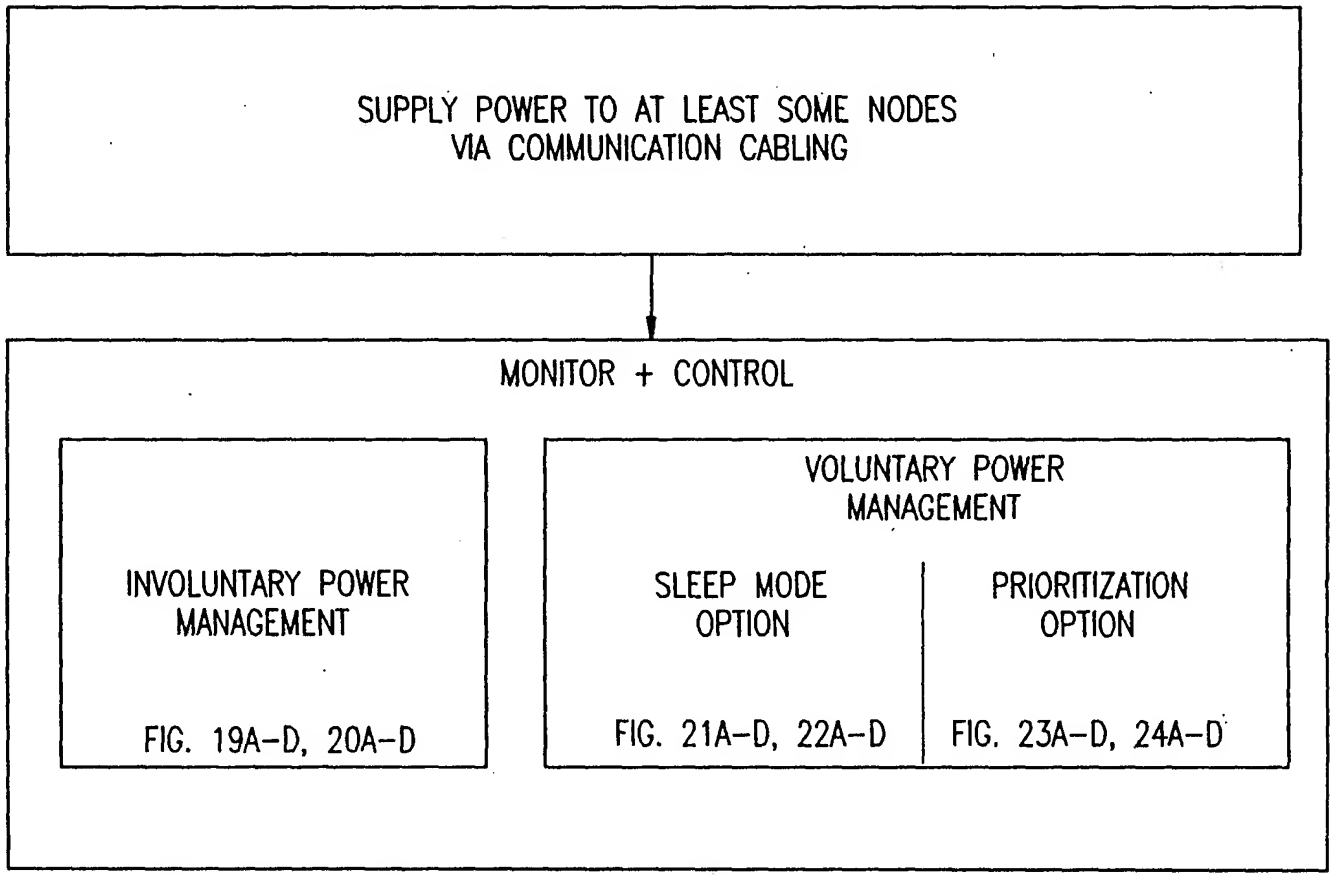

SUPPLY POWER TO AT LEAST SOME NODES
VIA COMMUNICATION CABLING
MONITOR + CONTROL
INVOLUNTARY POWER
MANAGEMENT
FIG. 19A-D, 20A-D
VOLUNTARY POWER
MANAGEMENT
SLEEP MODE
OPTION
FIG. 21A-D, 22A-D
PRIORITIZATION
OPTION
FIG. 23A-D, 24A-D

FIG. 17

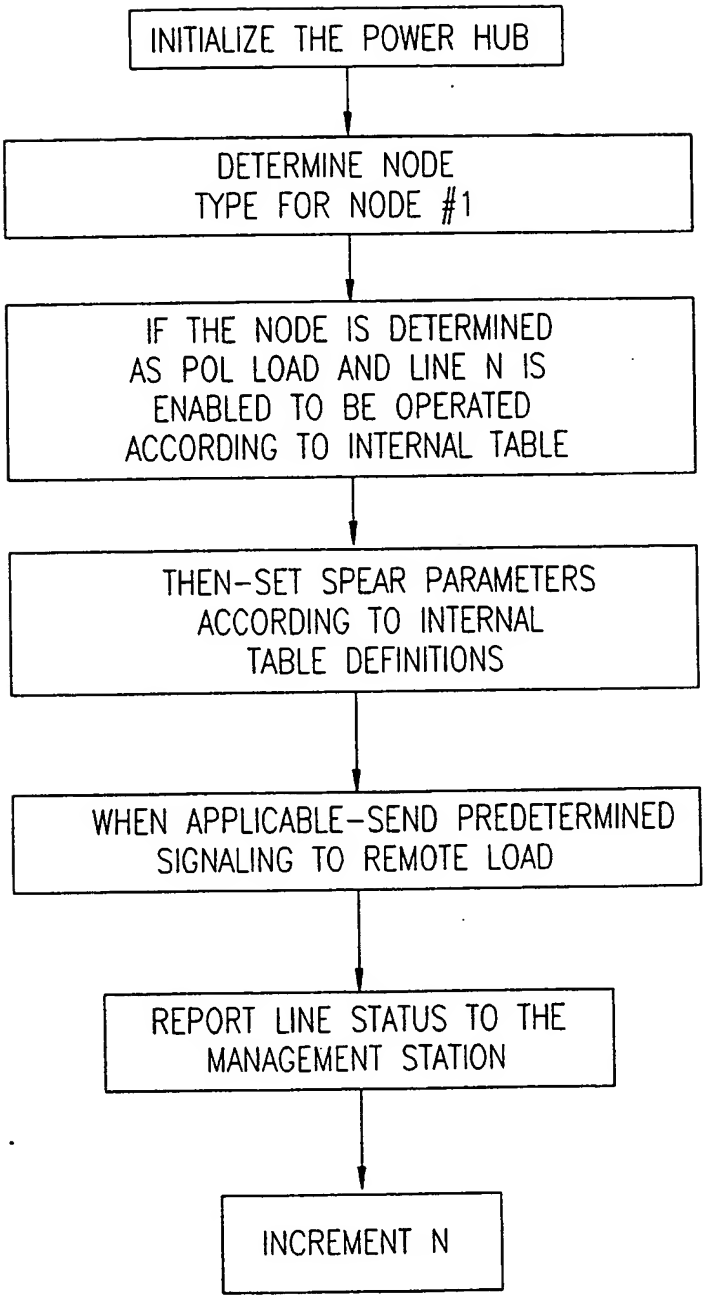

INITIALIZE THE POWER HUB
DETERMINE NODE TYPE FOR NODE #1
IF THE NODE IS DETERMINED AS POL LOAD AND LINE N IS ENABLED TO BE OPERATED ACCORDING TO INTERNAL TABLE
THEN-SET SPEAR PARAMETERS ACCORDING TO INTERNAL TABLE DEFINITIONS
WHEN APPLICABLE-SEND PREDETERMINED SIGNALING TO REMOTE LOAD
REPORT LINE STATUS TO THE MANAGEMENT STATION
INCREMENT N

FIG. 18A

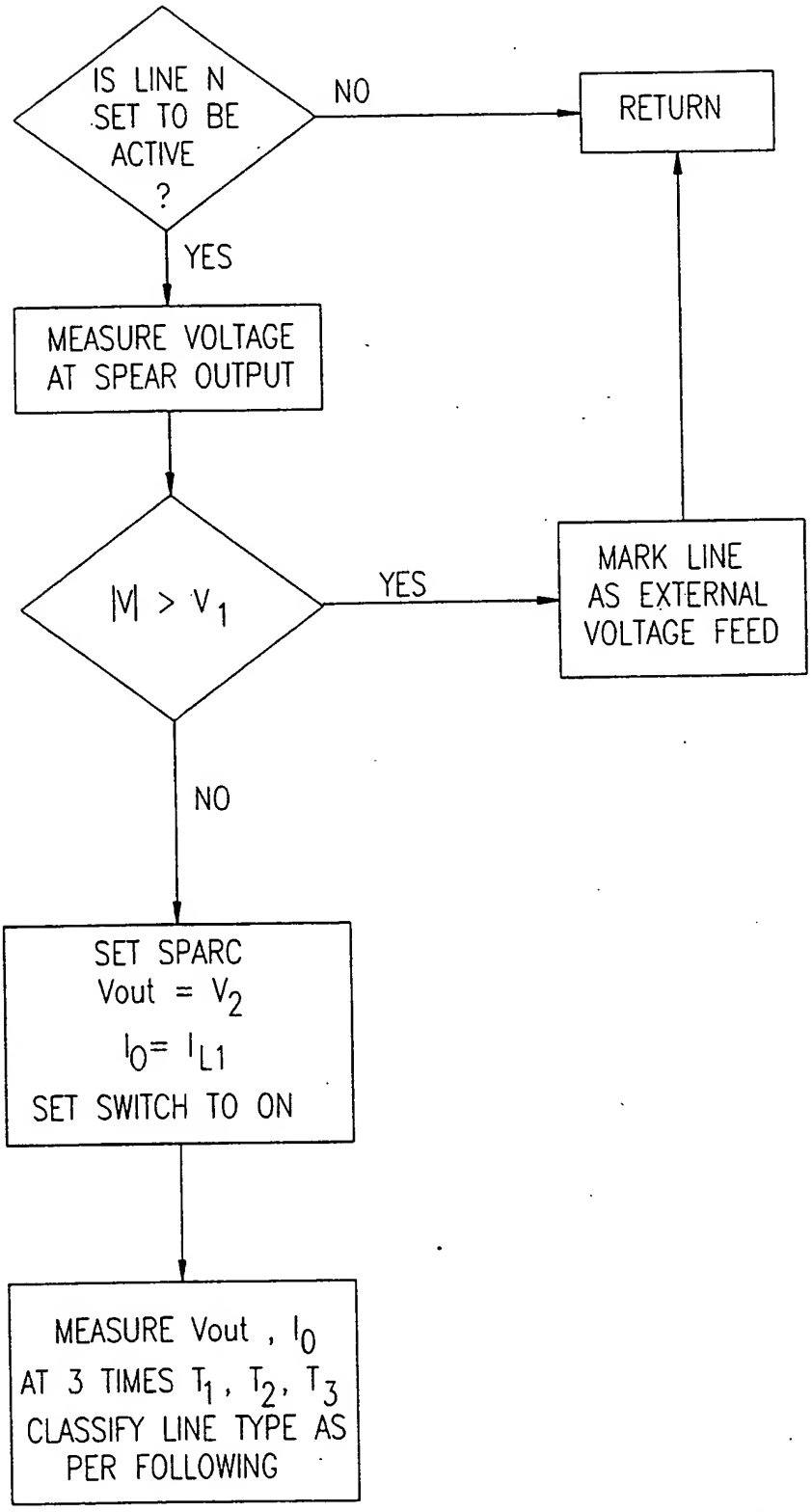
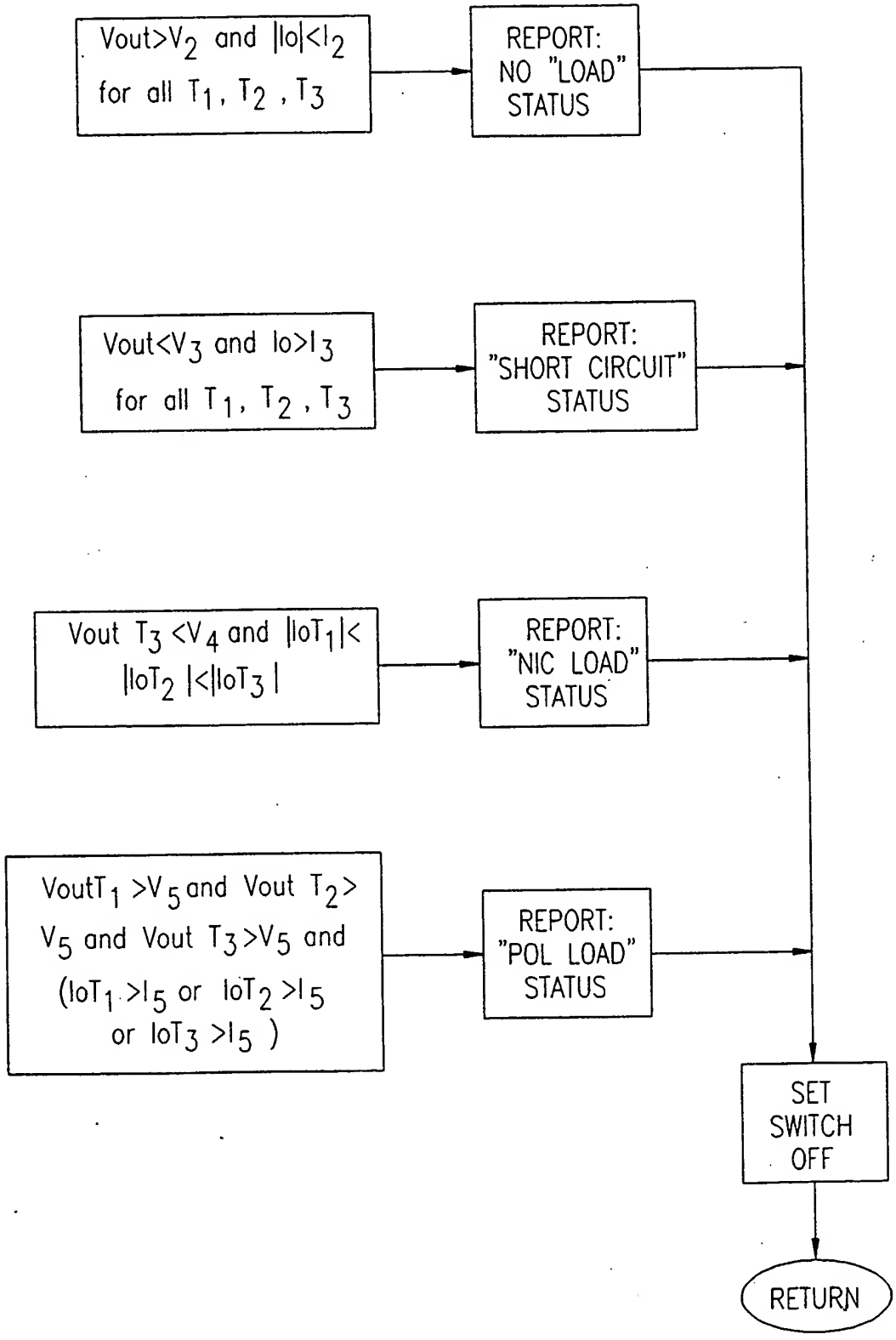

IS LINE N SET TO BE ACTIVE ?
NO
RETURN
YES
MEASURE VOLTAGE AT SPEAR OUTPUT
|V| > V1
YES
MARK LINE AS EXTERNAL VOLTAGE FEED
NO
SET SPARC
Vout = V2
I0= IL1
SET SWITCH TO ON
MEASURE Vout , I0
AT 3 TIMES T1 , T2, T3
CLASSIFY LINE TYPE AS PER FOLLOWING

FIG. 18B


Vout>V2 and |Io|<I2 for all T1, T2, T3
REPORT: NO "LOAD" STATUS
Vout<V3 and Io>I3 for all T1, T2, T3
REPORT: "SHORT CIRCUIT" STATUS
Vout T3 <V4 and |IoT1|< |IoT2 |<|IoT3 |
REPORT: "NIC LOAD" STATUS
VoutT1 >V5 and Vout T2> V5 and Vout T3>V5 and (IoT1 >I5 or IoT2 >I5 or IoT3 >I5)
REPORT: "POL LOAD" STATUS
SET SWITCH OFF
RETURN

INVOLUNTARY POWER MANAGEMENT FULL FUNCTIONALITY OR NO FUNCTIONALITY

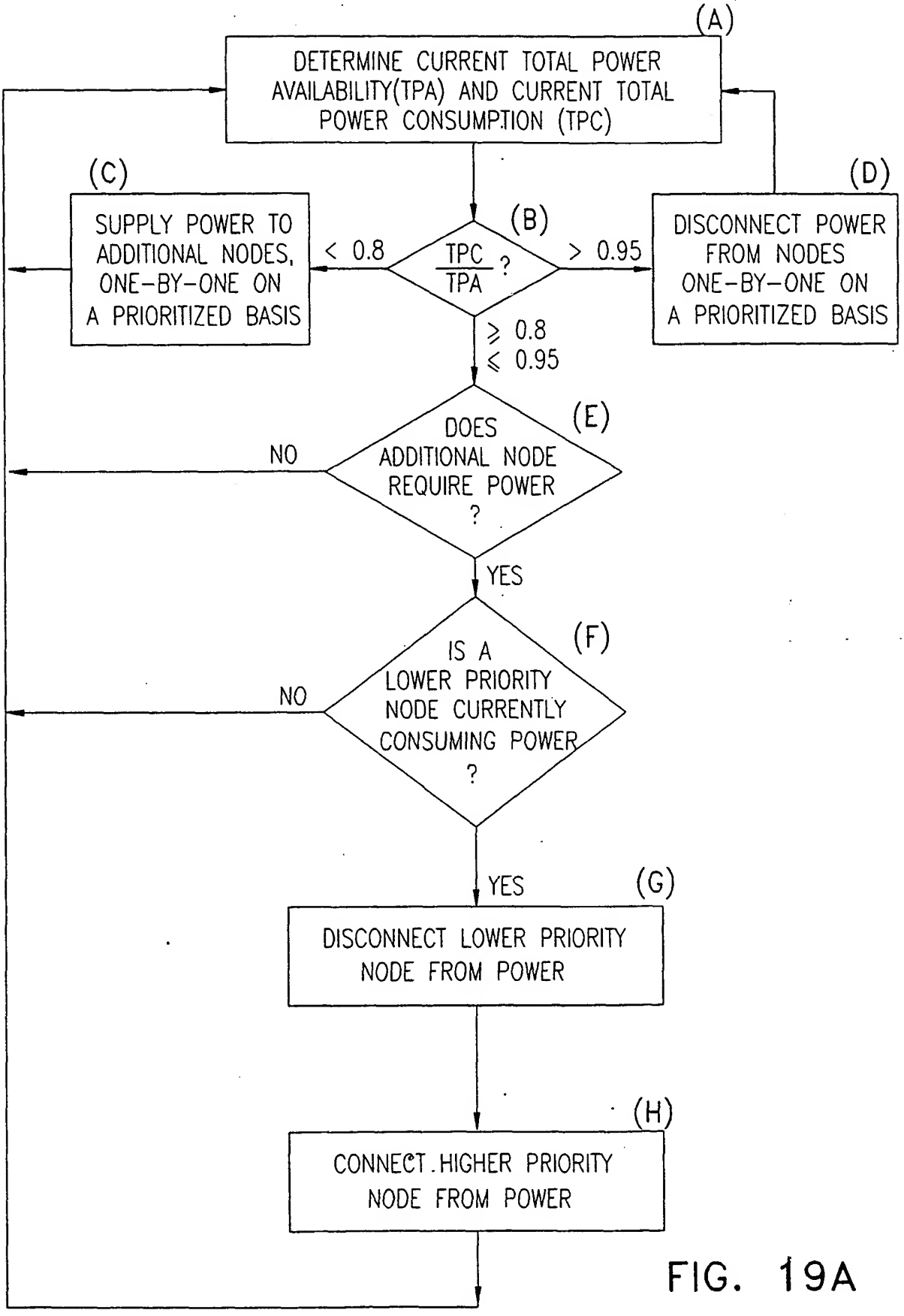


FIG. 19A

INVOLUNTARY POWER MANAGEMENT, FULL FUNCTIONALITY OR NO FUNCTIONALITY EMERGENCY OVERRIDE

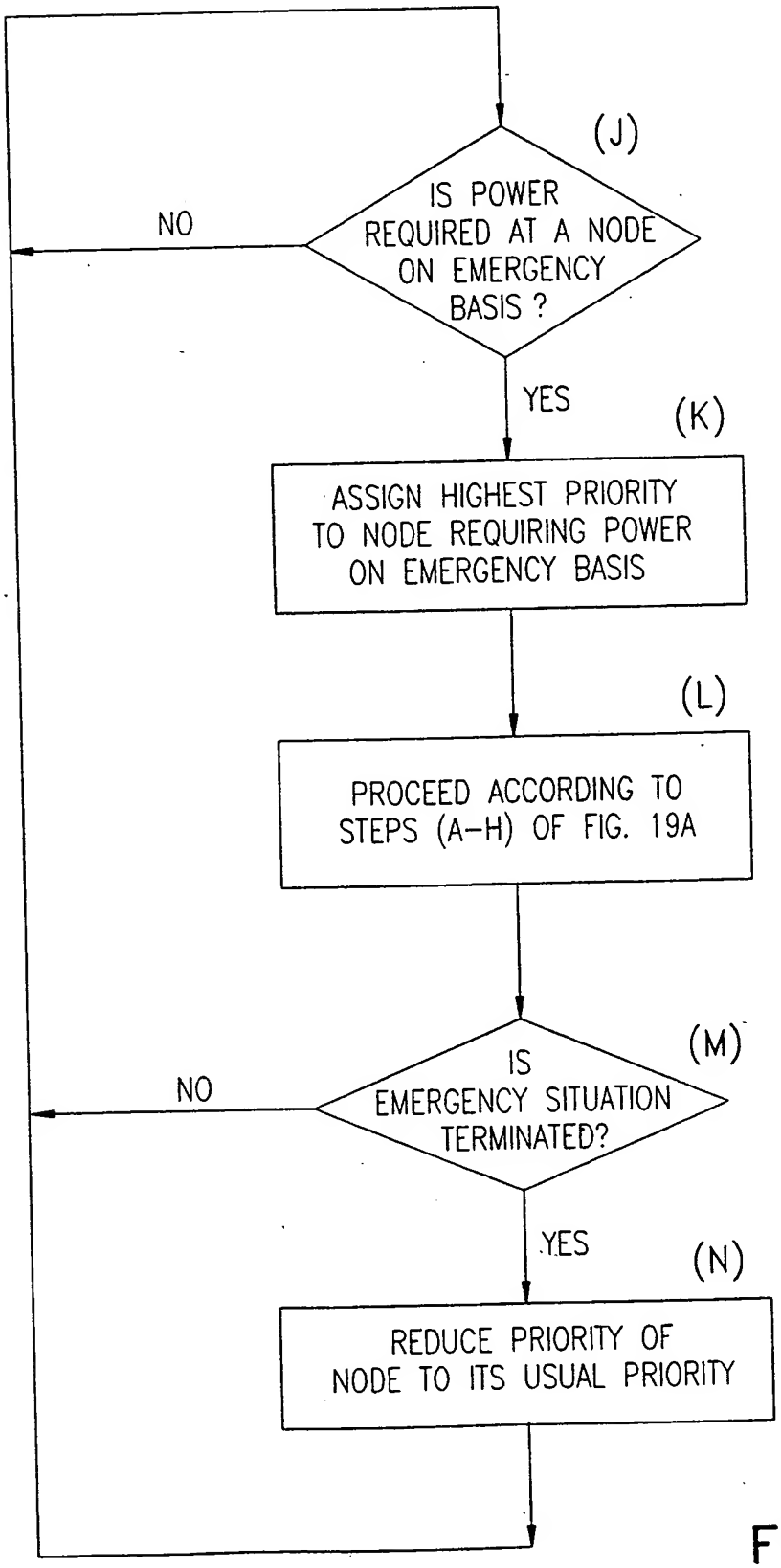


FIG. 19B

INVOLUNTARY POWER MANAGEMENT FULL
FUNCTIONALITY OR NO FUNCTIONALITY
QUEUE CONTROLLRD PRIORITY

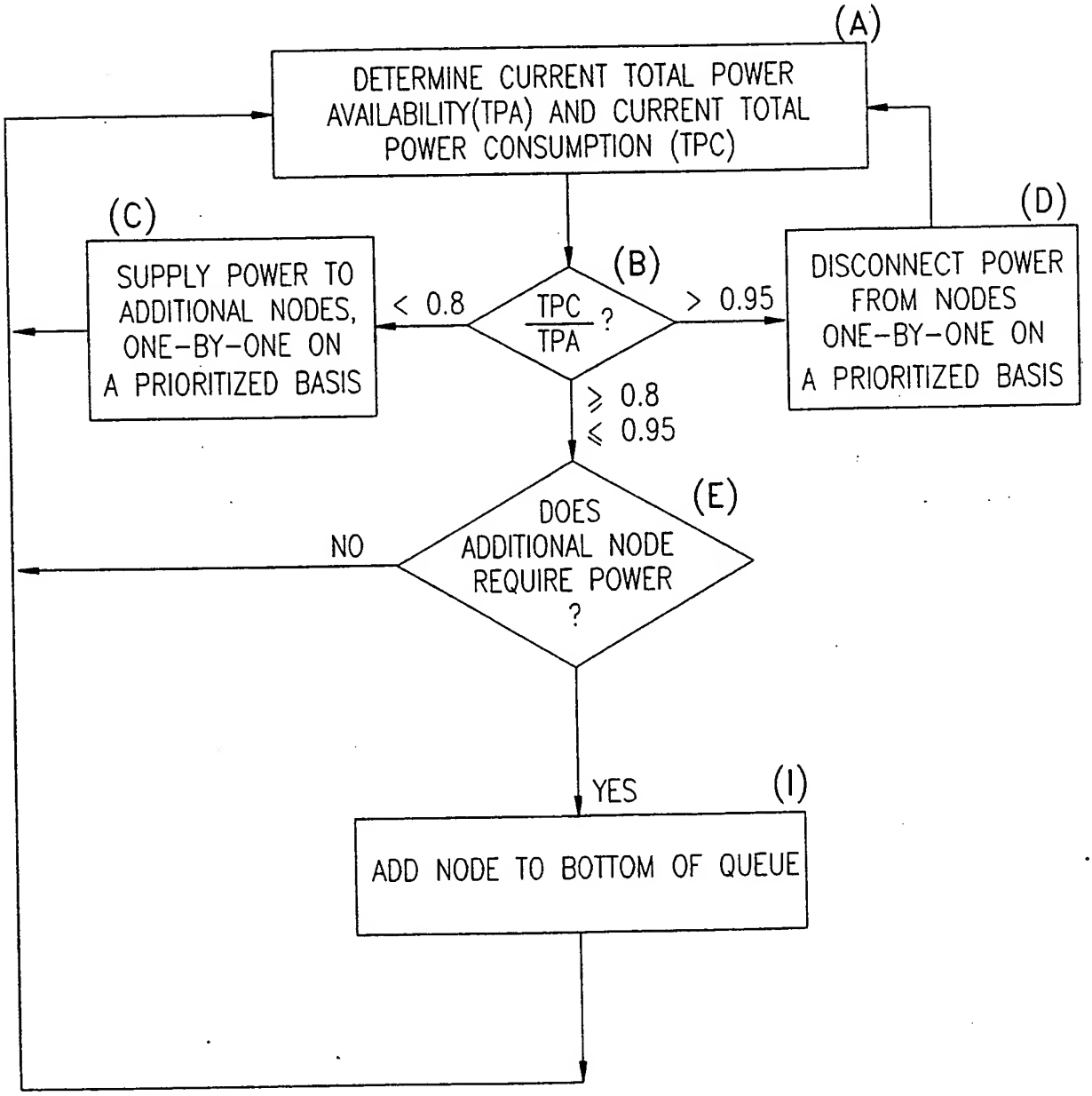


FIG. 1.9C

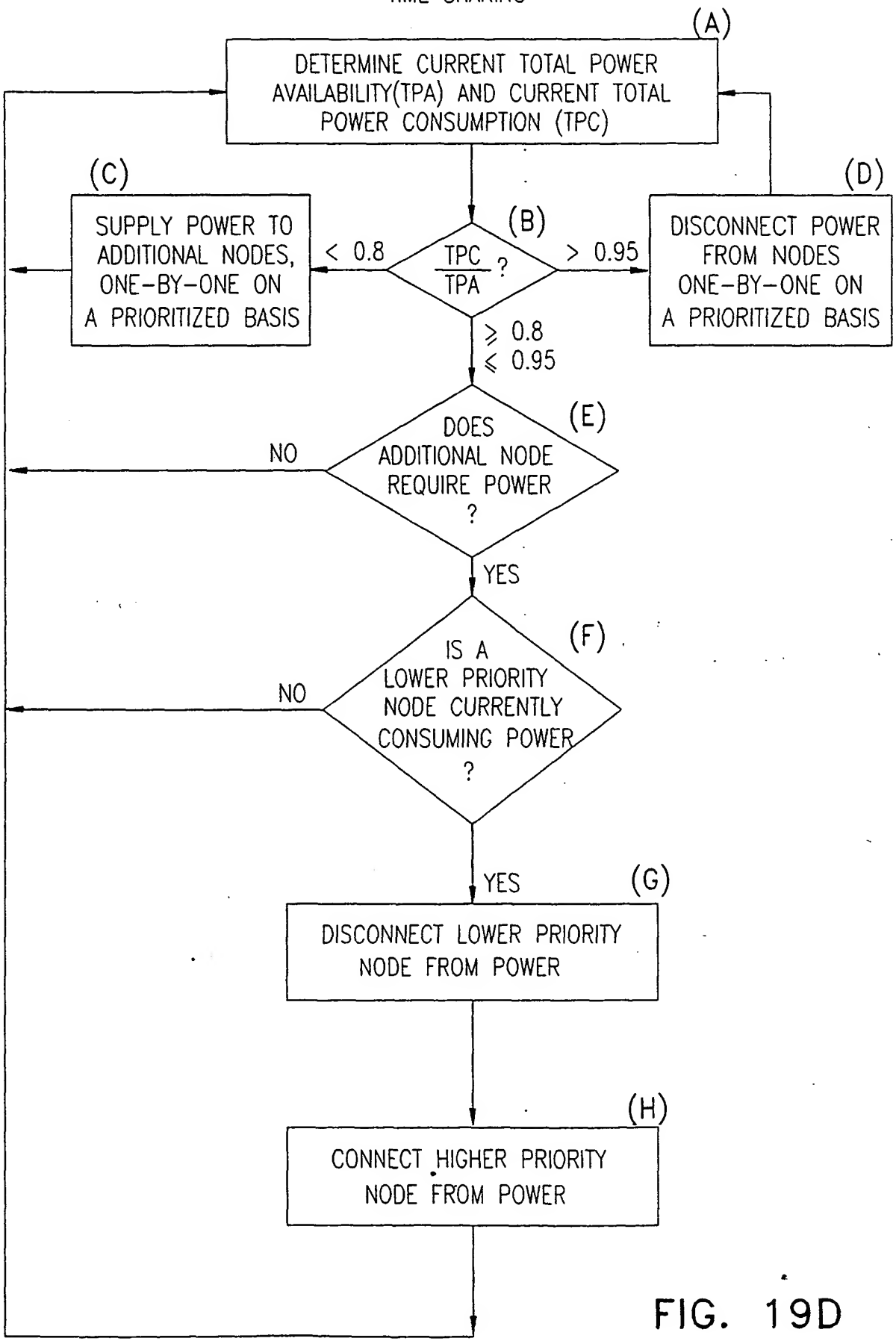

INVOLUNTARY POWER MANAGEMENT FULL FUNCTIONALITY OR NO FUNCTIONALITY TIME SHARING
(A)
DETERMINE CURRENT TOTAL POWER AVAILABILITY(TPA) AND CURRENT TOTAL POWER CONSUMPTION (TPC)
(B)
TPC / TPA ?
< 0.8
> 0.95
≥ 0.8 ≤ 0.95
(C)
SUPPLY POWER TO ADDITIONAL NODES, ONE-BY-ONE ON A PRIORITIZED BASIS
(D)
DISCONNECT POWER FROM NODES ONE-BY-ONE ON A PRIORITIZED BASIS
(E)
DOES ADDITIONAL NODE REQUIRE POWER ?
NO
YES
(F)
IS A LOWER PRIORITY NODE CURRENTLY CONSUMING POWER ?
NO
YES
(G)
DISCONNECT LOWER PRIORITY NODE FROM POWER
(H)
CONNECT HIGHER PRIORITY NODE FROM POWER

FIG. 19D

INVOLUNTARY POWER MANAGEMENT FULL FUNCTIONALITY OR REDUCED FUNCTIONALITY

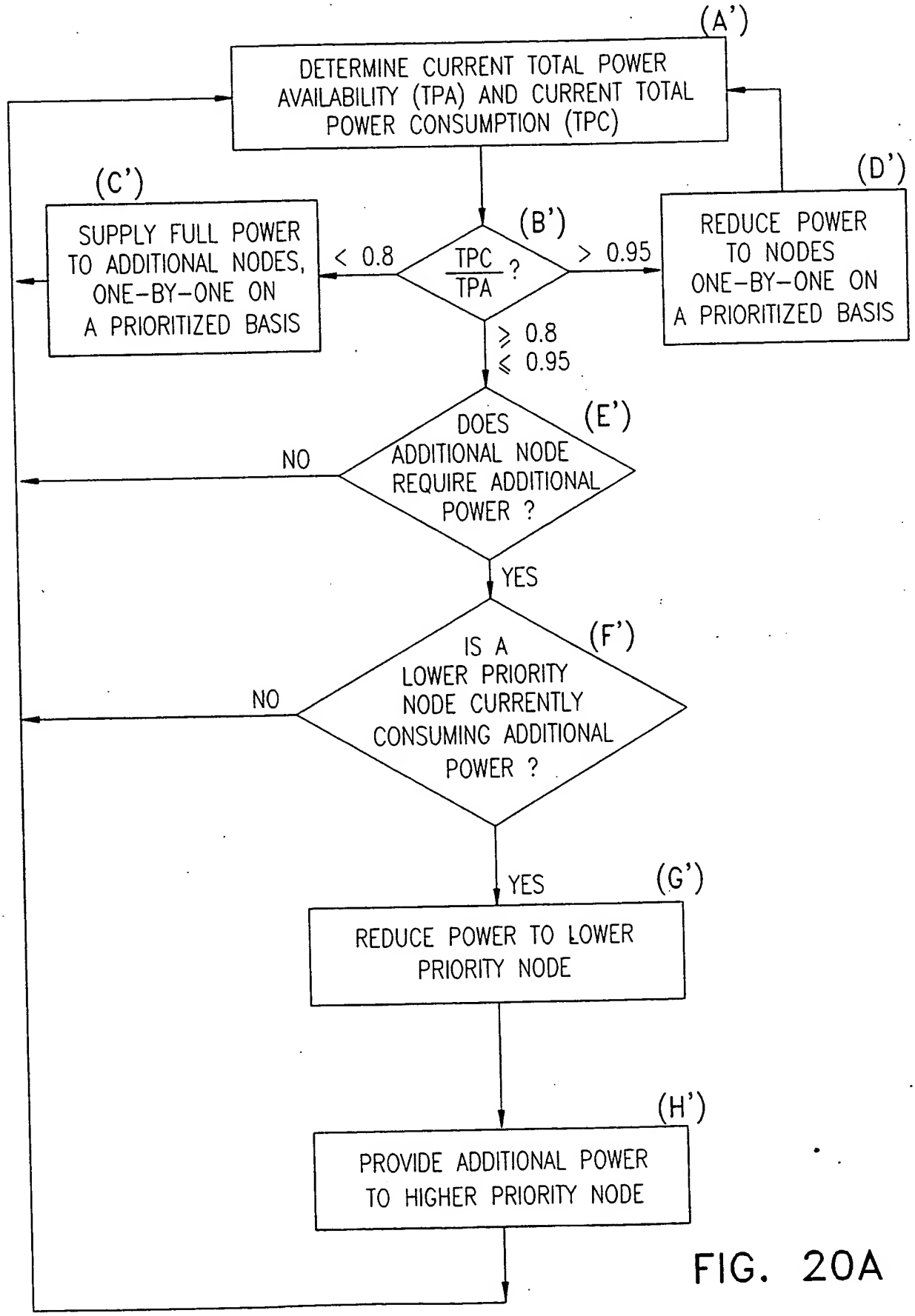


FIG. 20A

INVOLUNTARY POWER MANAGEMENT, FULL
FUNCTIONALITY OR REDUCED FUNCTIONALITY, EMERGENCY OVERRIDE

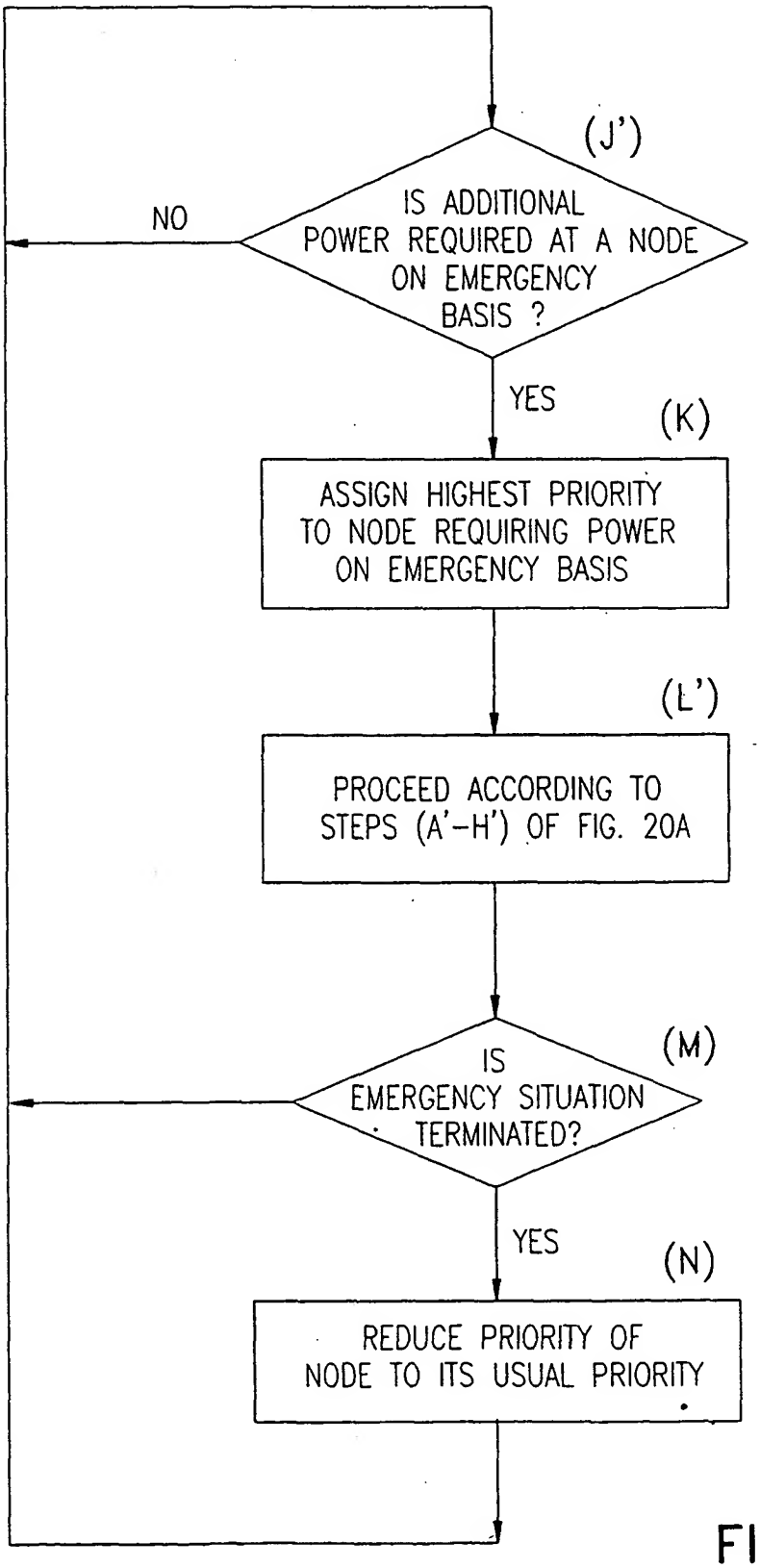


FIG. 20B

INVOLUNTARY POWER MANAGEMENT FULL
FUNCTIONALITY OR REDUCED FUNCTIONALITY
QUEUE CONTROLLRD PRIORITY

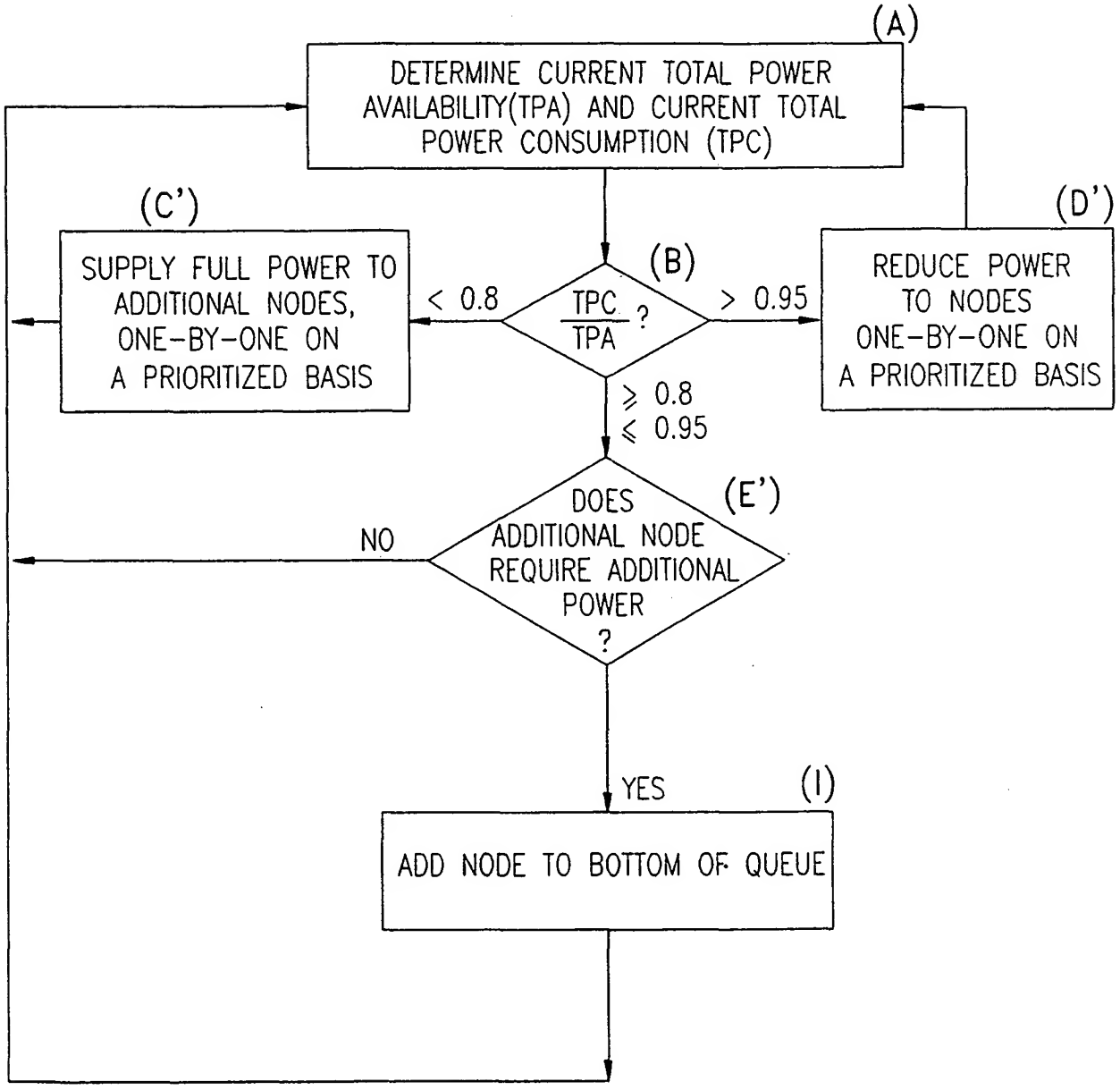


FIG. 20C

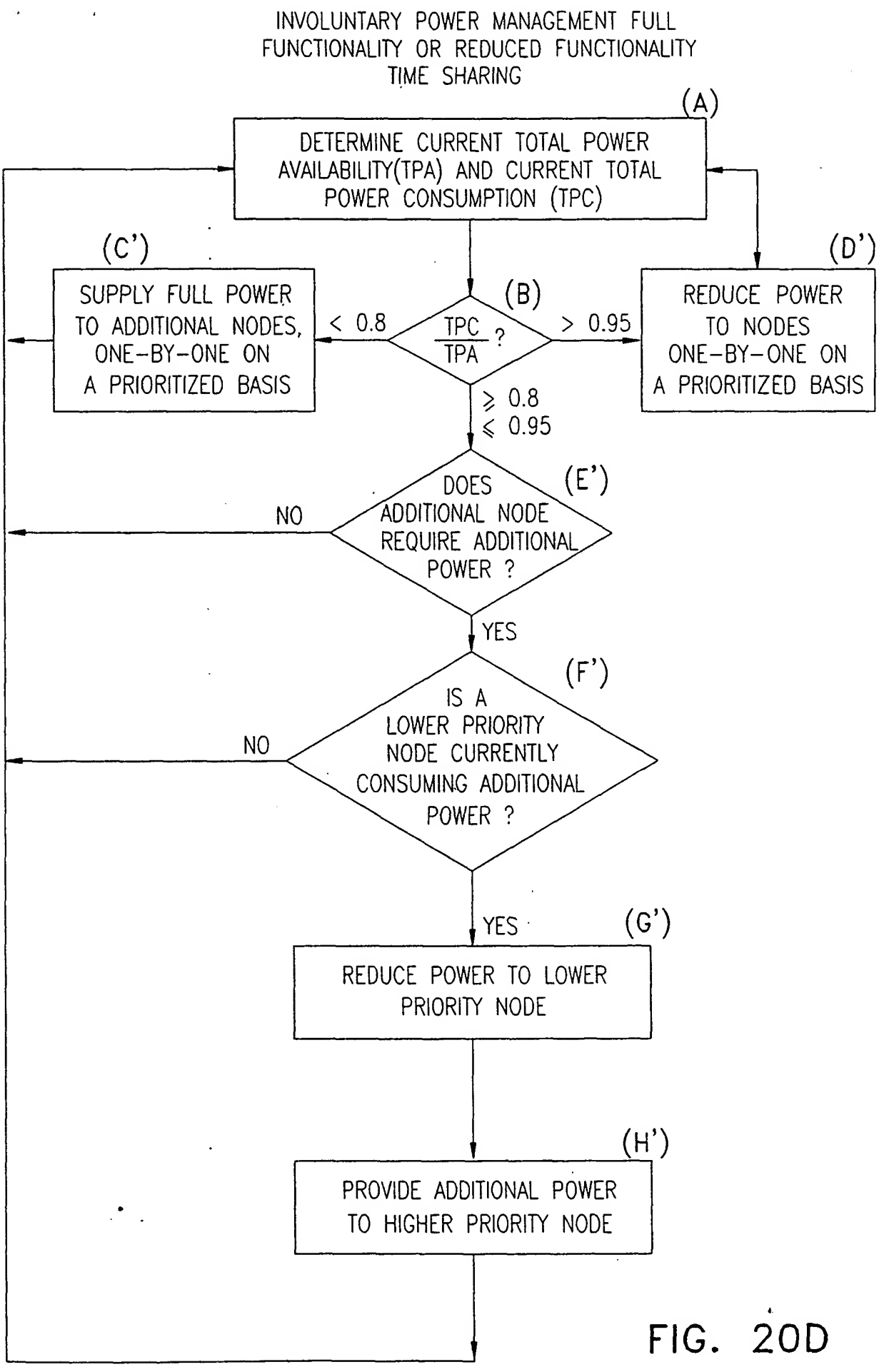

INVOLUNTARY POWER MANAGEMENT FULL FUNCTIONALITY OR REDUCED FUNCTIONALITY TIME SHARING
(A)
DETERMINE CURRENT TOTAL POWER AVAILABILITY(TPA) AND CURRENT TOTAL POWER CONSUMPTION (TPC)
(B)
TPC / TPA ?
< 0.8
> 0.95
≥ 0.8 ≤ 0.95
(C')
SUPPLY FULL POWER TO ADDITIONAL NODES, ONE-BY-ONE ON A PRIORITIZED BASIS
(D')
REDUCE POWER TO NODES ONE-BY-ONE ON A PRIORITIZED BASIS
(E')
DOES ADDITIONAL NODE REQUIRE ADDITIONAL POWER ?
NO
YES
(F')
IS A LOWER PRIORITY NODE CURRENTLY CONSUMING ADDITIONAL POWER ?
NO
YES
(G')
REDUCE POWER TO LOWER PRIORITY NODE
(H')
PROVIDE ADDITIONAL POWER TO HIGHER PRIORITY NODE

FIG. 20D

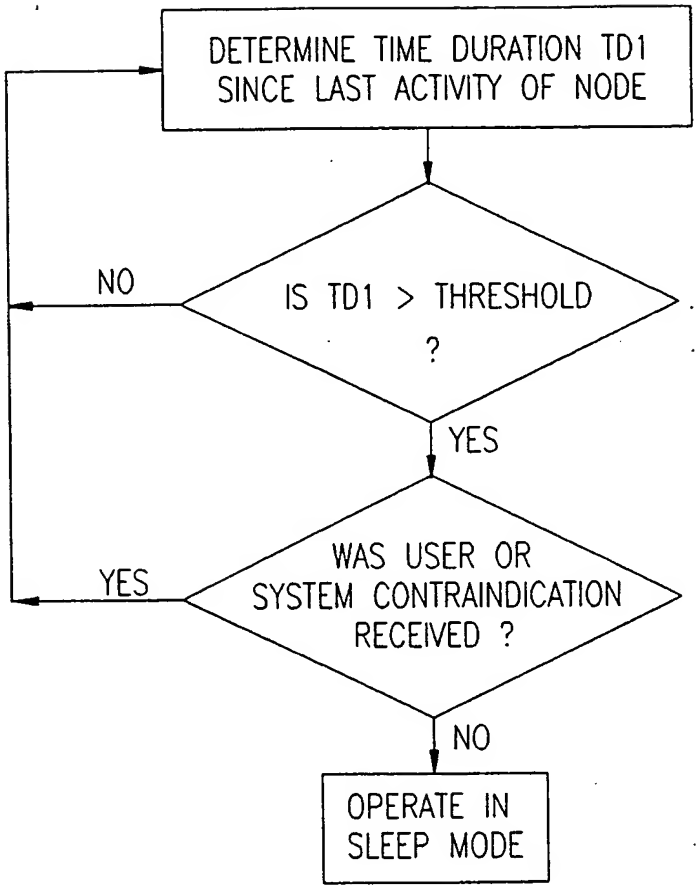


FIG. 21A

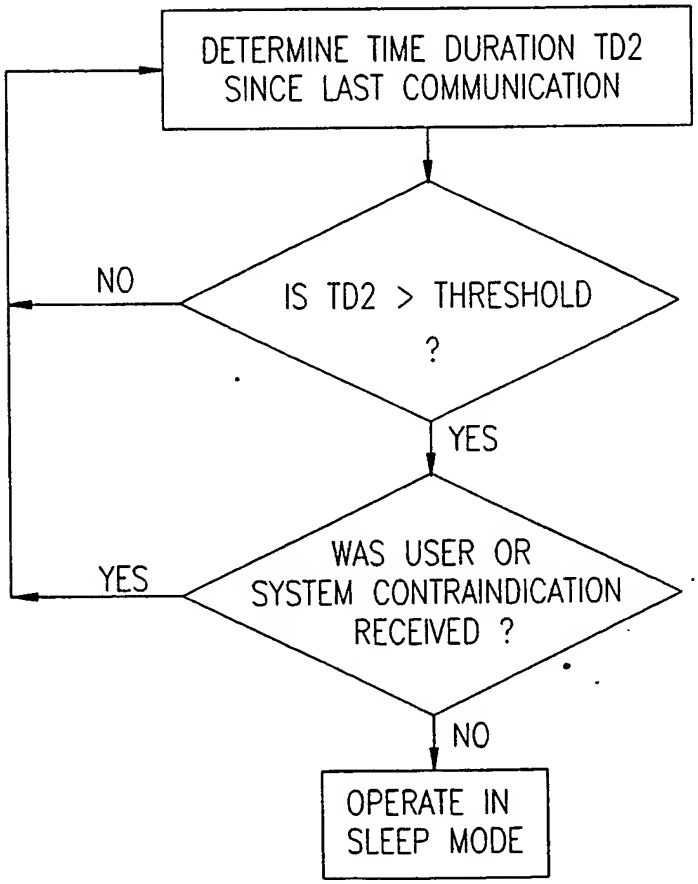


FIG. 21B

FIG. 21C

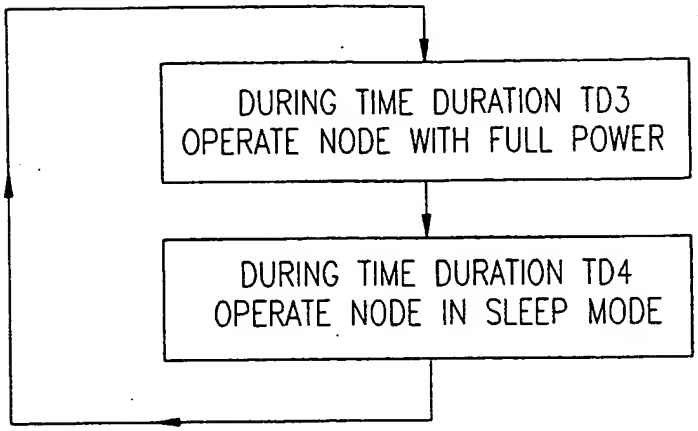
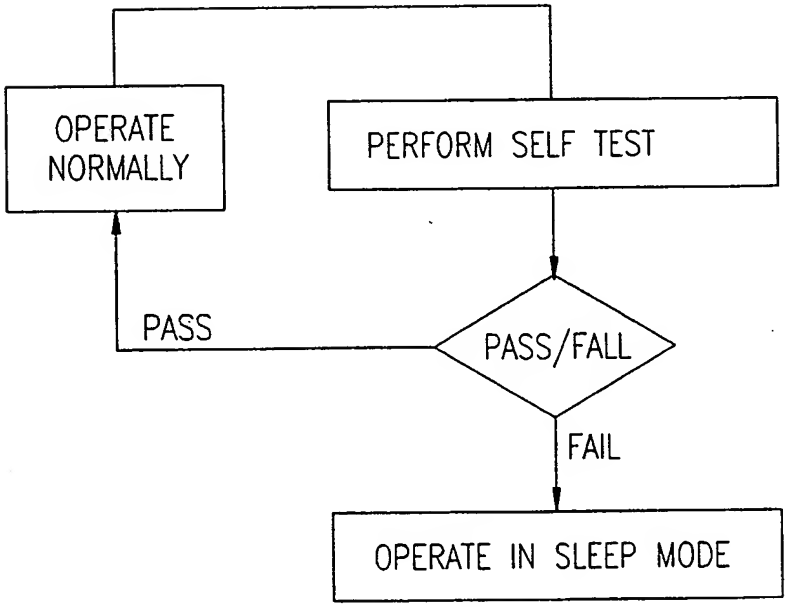


FIG. 21D



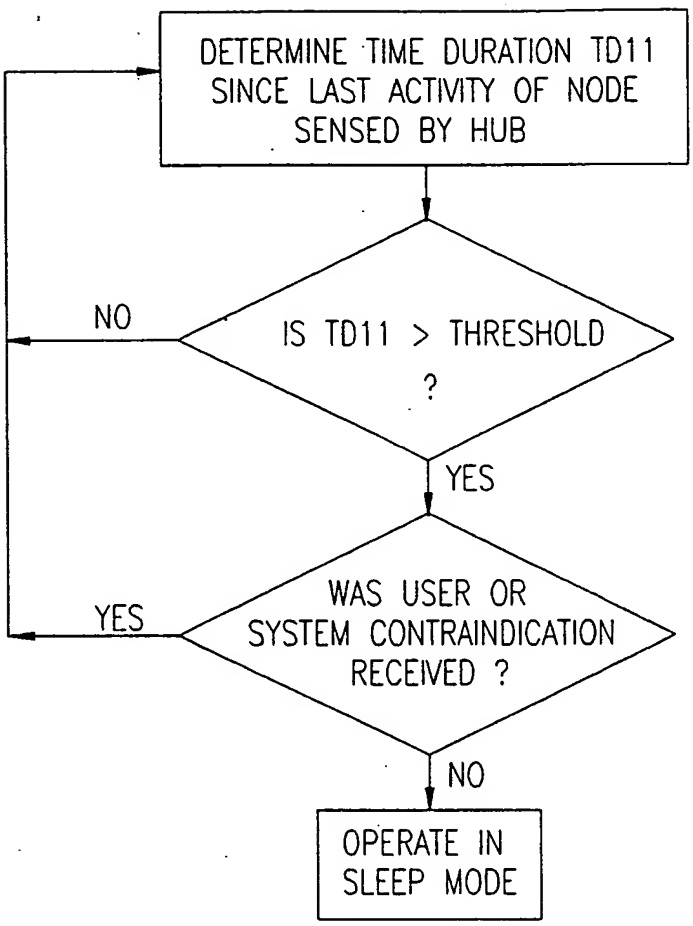


FIG. 22A

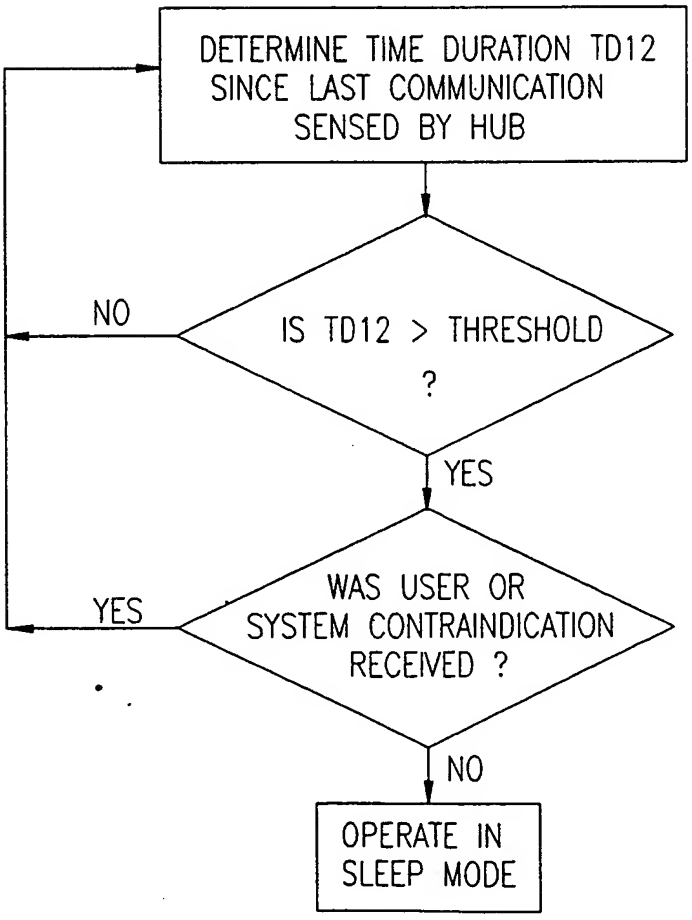


FIG. 22B

FIG. 22C

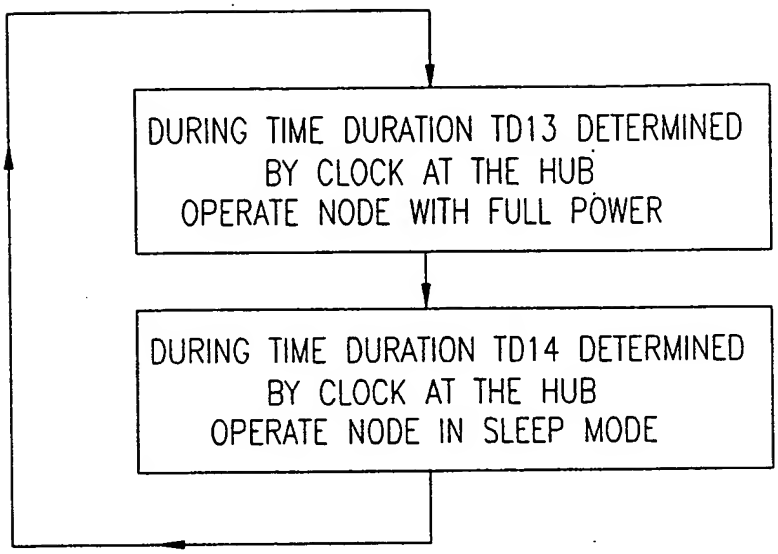
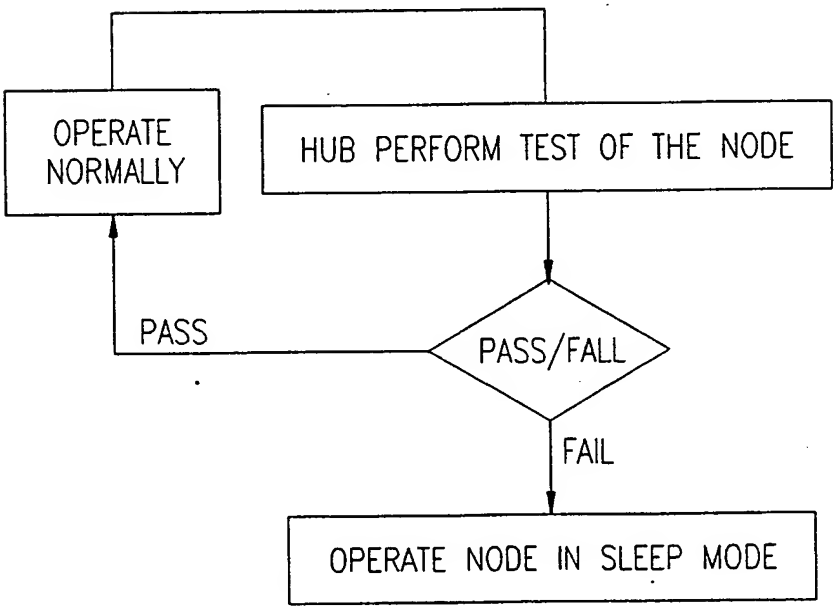


FIG. 22D



VOLUNTARY POWER MANAGEMENT FULL FUNCTIONALITY OR NO FUNCTIONALITY

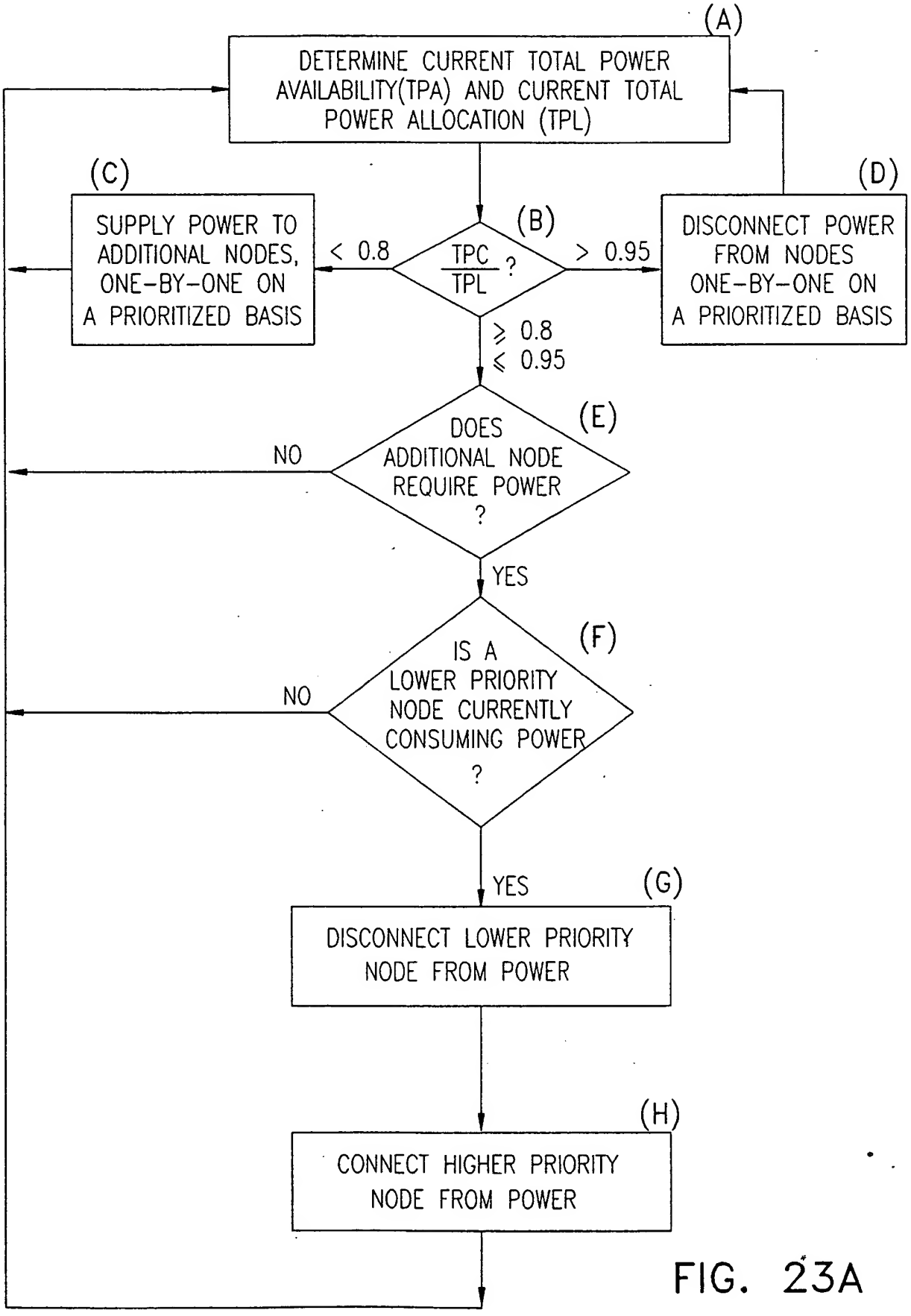


FIG. 23A

VOLUNTARY POWER MANAGEMENT, FULL FUNCTIONALITY OR NO FUNCTIONALITY EMERGENCY OVERRIDE

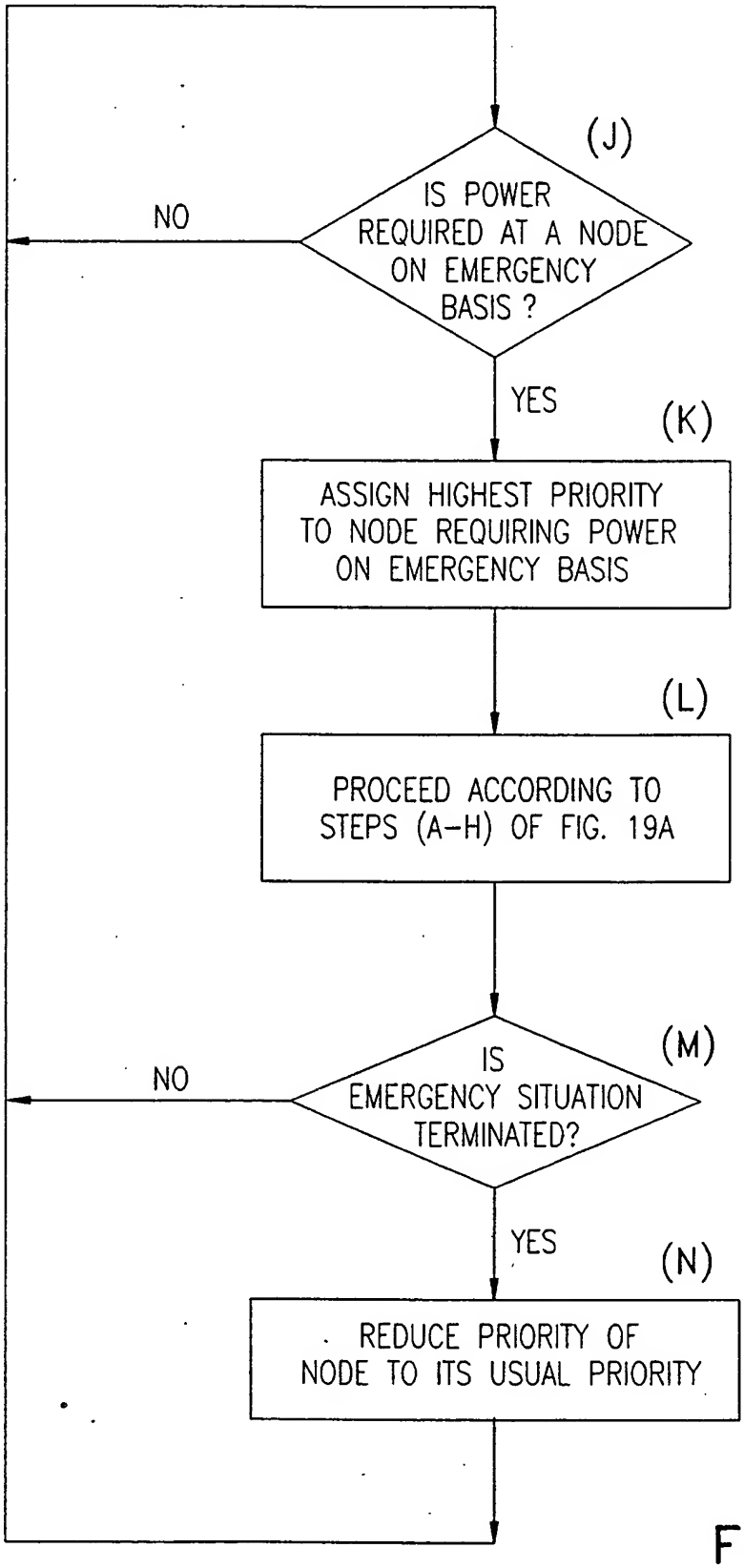


FIG. 23B

VOLUNTARY POWER MANAGEMENT FULL
FUNCTIONALITY OR NO FUNCTIONALITY
QUEUE CONTROLLED PRIORITY

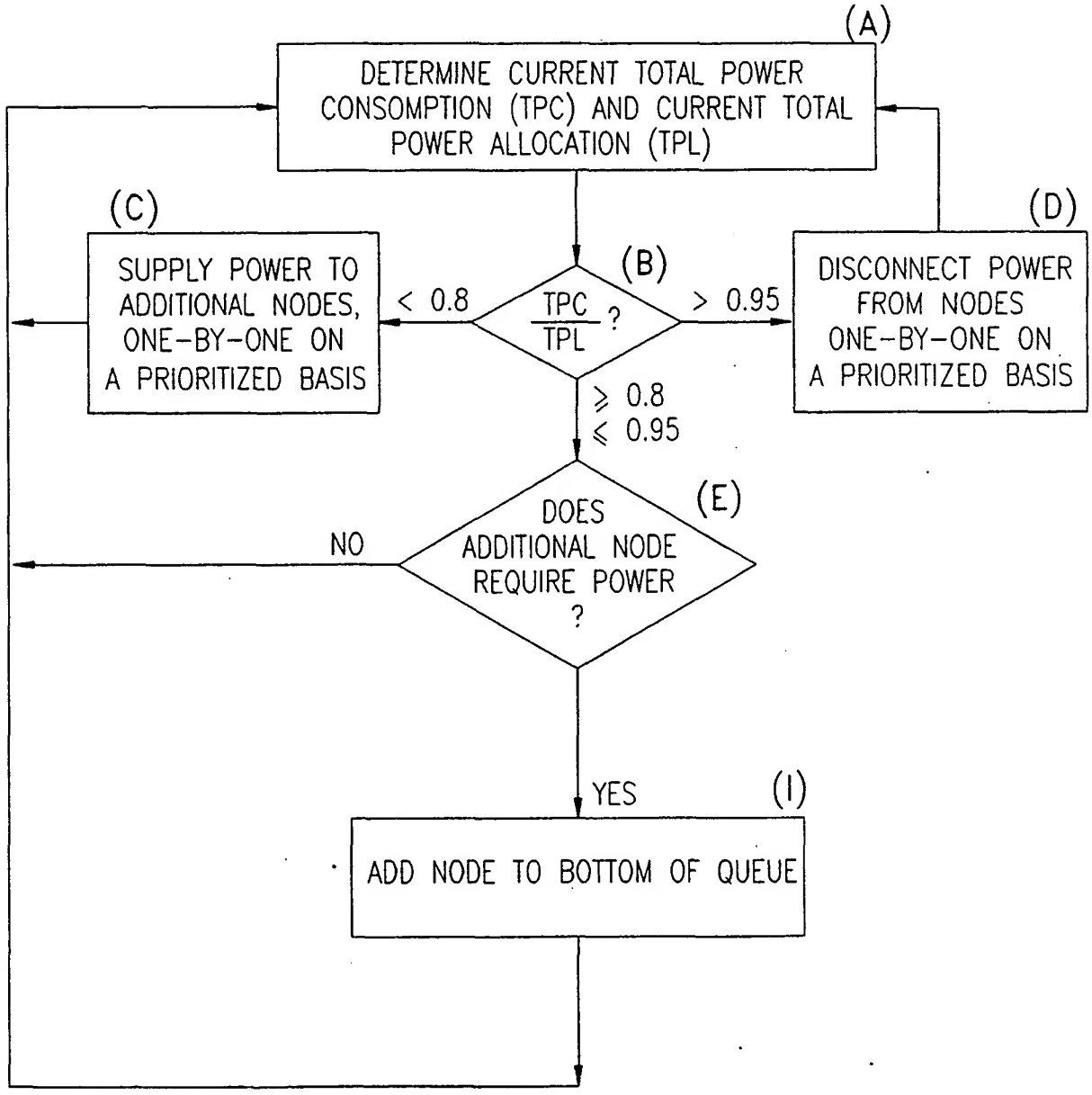


FIG. 23C

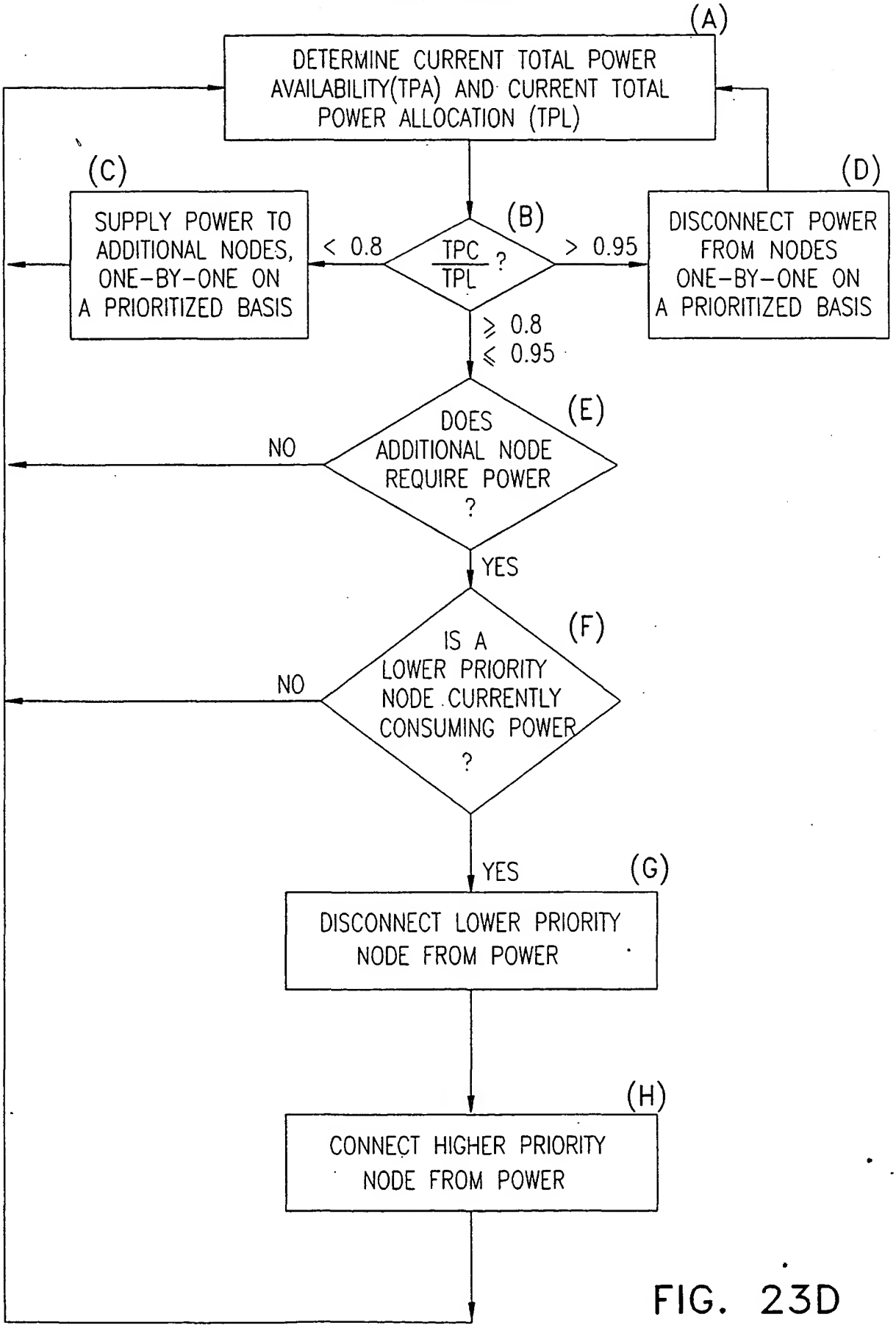

VOLUNTARY POWER MANAGEMENT FULL FUNCTIONALITY OR NO FUNCTIONALITY TIME SHARING
(A)
DETERMINE CURRENT TOTAL POWER AVAILABILITY(TPA) AND CURRENT TOTAL POWER ALLOCATION (TPL)
(B)
TPC / TPL ?
< 0.8
> 0.95
≥ 0.8
≤ 0.95
(C)
SUPPLY POWER TO ADDITIONAL NODES, ONE-BY-ONE ON A PRIORITIZED BASIS
(D)
DISCONNECT POWER FROM NODES ONE-BY-ONE ON A PRIORITIZED BASIS
(E)
DOES ADDITIONAL NODE REQUIRE POWER ?
NO
YES
(F)
IS A LOWER PRIORITY NODE CURRENTLY CONSUMING POWER ?
NO
YES
(G)
DISCONNECT LOWER PRIORITY NODE FROM POWER
(H)
CONNECT HIGHER PRIORITY NODE FROM POWER

FIG. 23D

VOLUNTARY POWER MANAGEMENT FULL FUNCTIONALITY OR REDUCED FUNCTIONALITY

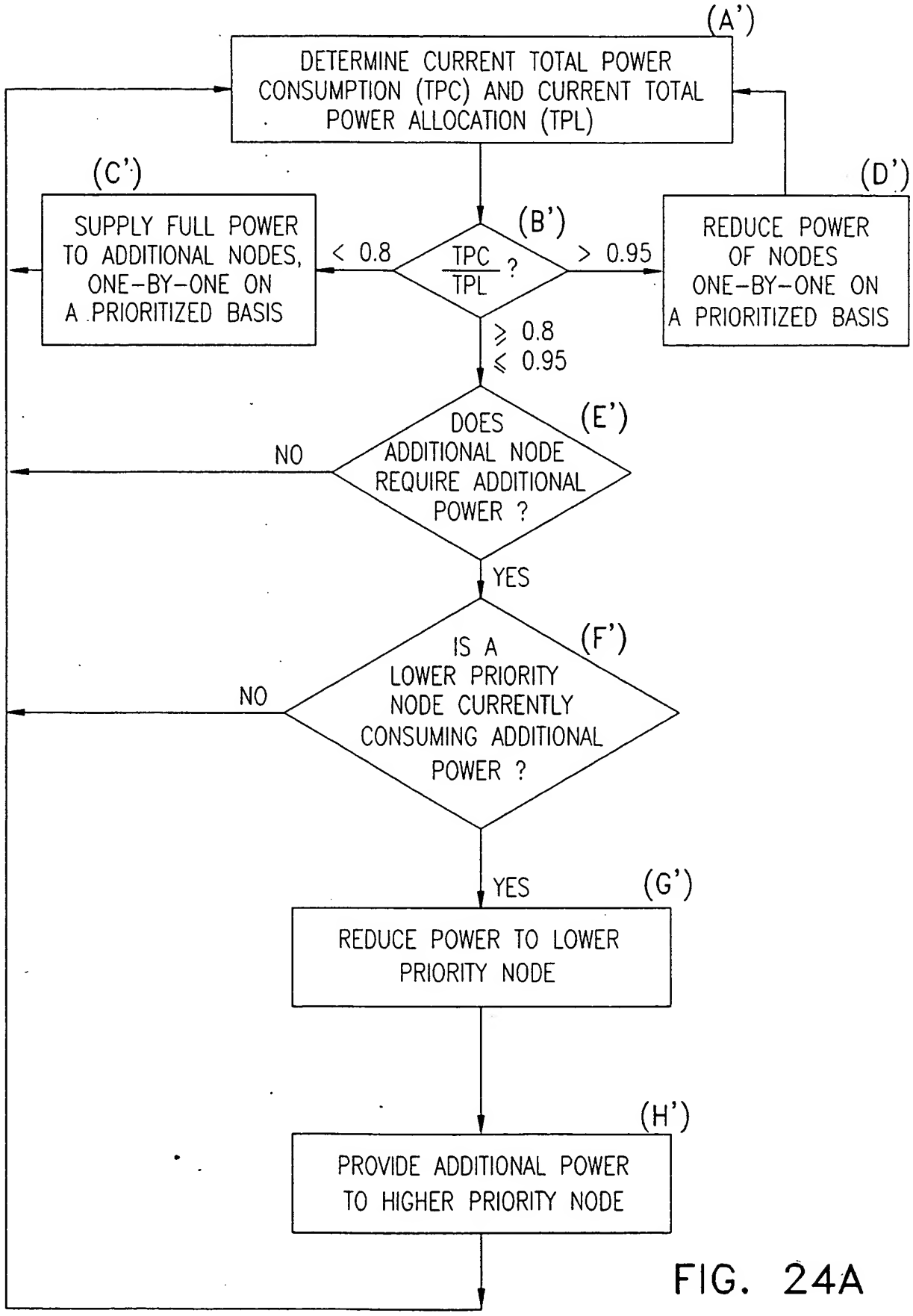


FIG. 24A

VOLUNTARY POWER MANAGEMENT, FULL
FUNCTIONALITY OR REDUCED FUNCTIONALTY, EMERGENCY OVERRIDE

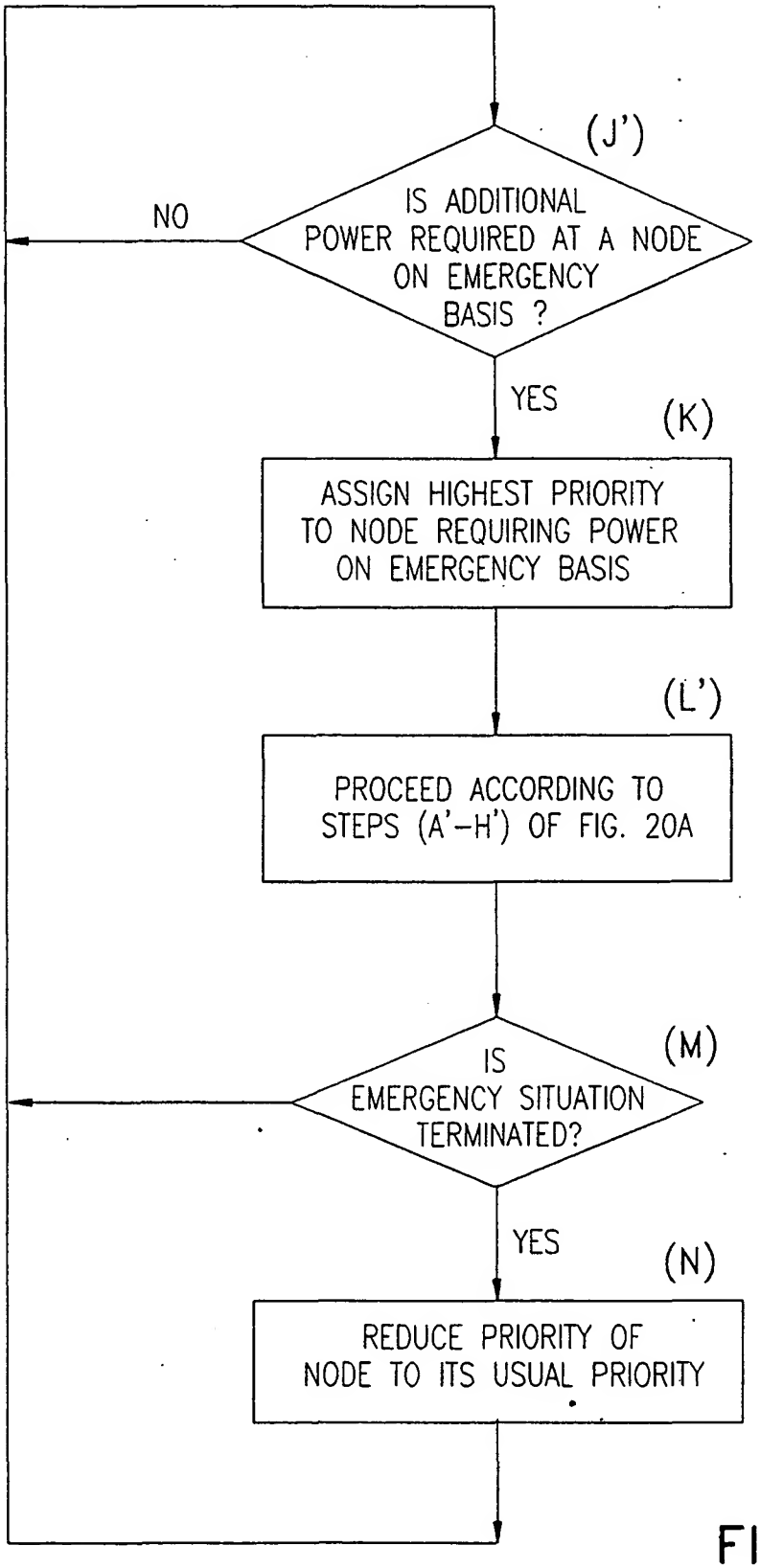


FIG. 24B

VOLUNTARY POWER MANAGEMENT FULL
FUNCTIONALITY OR REDUCED FUNCTIONALITY
QUEUE CONTROLLED PRIORITY

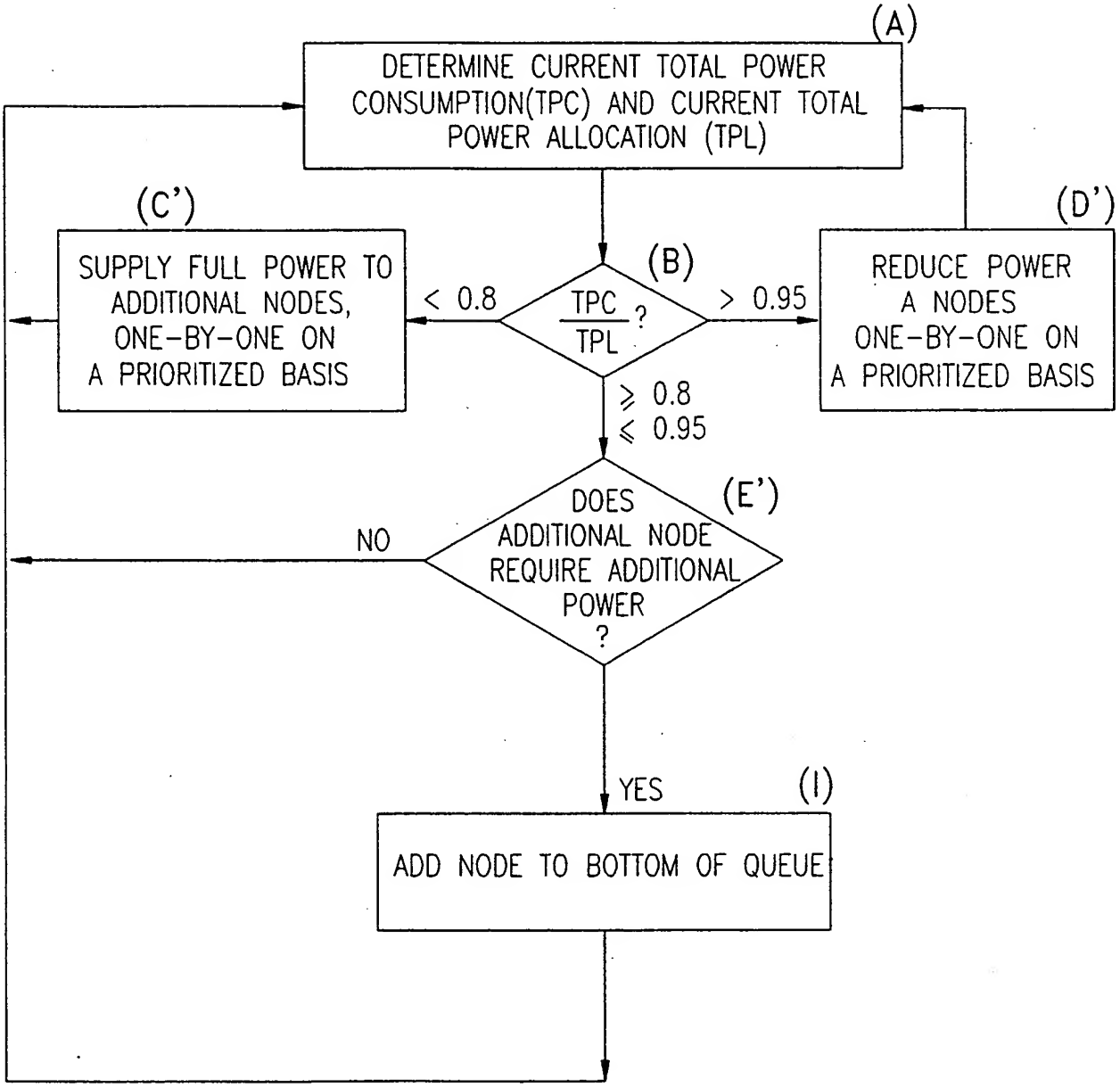


FIG. 24C

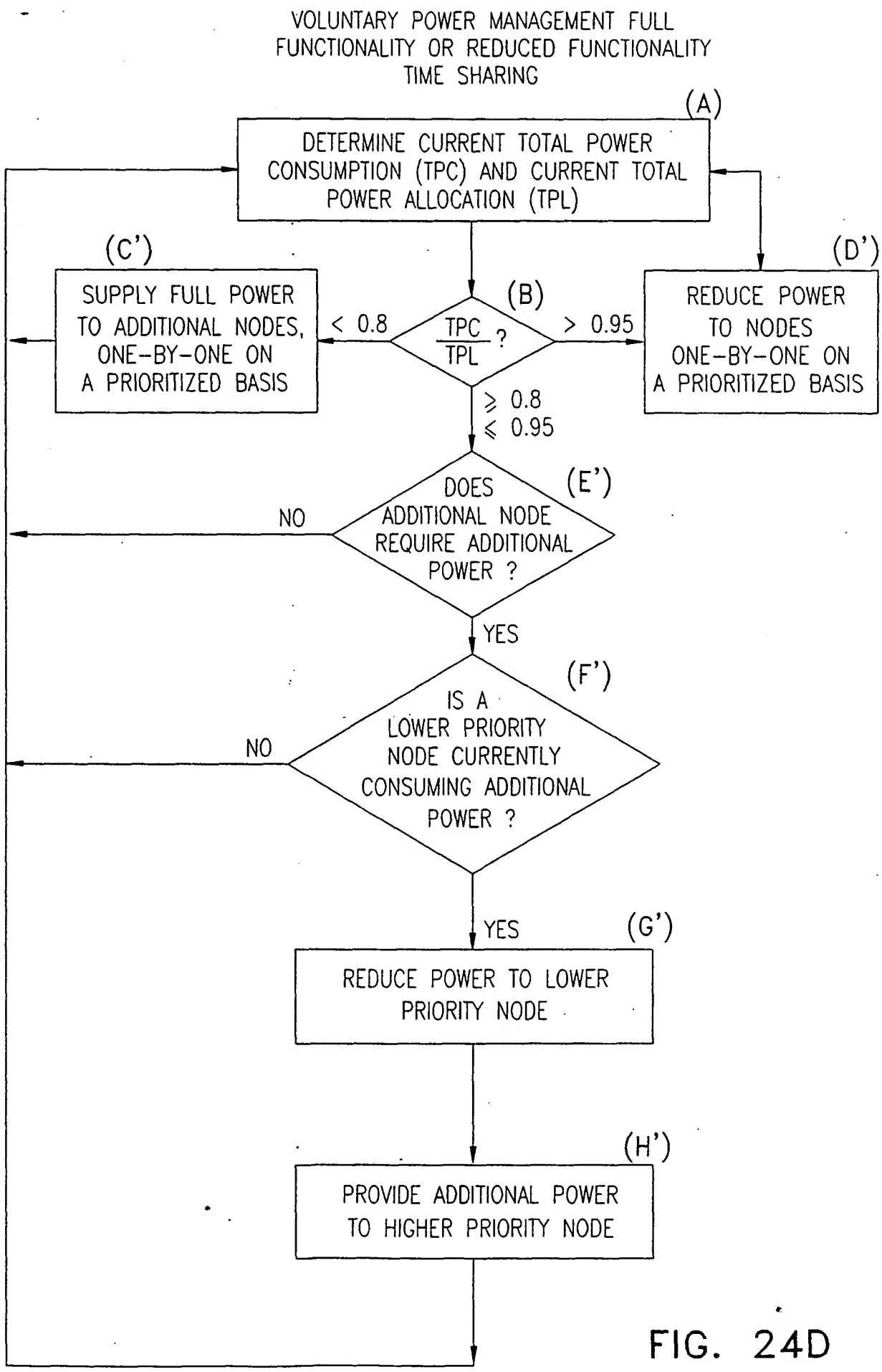

VOLUNTARY POWER MANAGEMENT FULL FUNCTIONALITY OR REDUCED FUNCTIONALITY TIME SHARING
(A)
DETERMINE CURRENT TOTAL POWER CONSUMPTION (TPC) AND CURRENT TOTAL POWER ALLOCATION (TPL)
(B)
TPC / TPL ?
< 0.8
> 0.95
≥ 0.8 ≤ 0.95
(C')
SUPPLY FULL POWER TO ADDITIONAL NODES, ONE-BY-ONE ON A PRIORITIZED BASIS
(D')
REDUCE POWER TO NODES ONE-BY-ONE ON A PRIORITIZED BASIS
(E')
DOES ADDITIONAL NODE REQUIRE ADDITIONAL POWER ?
NO
YES
(F')
IS A LOWER PRIORITY NODE CURRENTLY CONSUMING ADDITIONAL POWER ?
NO
YES
(G')
REDUCE POWER TO LOWER PRIORITY NODE
(H')
PROVIDE ADDITIONAL POWER TO HIGHER PRIORITY NODE

FIG. 24D